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Seventy-four high school seniors participated in a study that examined the construct validity of vocabulary tests and the nature of verbal ability by integrating findings and theories of cognitive psychology with those of differential psychology. The subjects completed three kinds of measurement instruments: (1) an experimental faceted vocabulary test, (2) reference ability tests, and (3) a verbal exposure instrument, which assessed frequency and time spent in reading, writing, doing homework, and viewing television. The results indicated that vocabulary item difficulty increased with word abstractness, word infrequency, when item format required more precise word knowledge, and when an item required definition as opposed to recognition of the word. The findings suggested that partial concepts were prevalent in the young adult subjects and that word acquisition was a gradual process. The results also showed that verbal ability as represented by reading comprehension and reading vocabulary tests was best measured by frequent or medium-frequency words rather than by rare words. On the other hand, difficult recognition vocabulary tests such as advanced vocabulary tests seemed to measure mainly sources of difficulty due to infrequent words. (FL)

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TRAIT AND PROCESS ASPECTS OF VOCABULARY KNOWLEDGE AND VERBAL ABILITY

BRACHIA MARSHALEK

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The purpose of this study was to investigate the construct validity of vocabulary tests and the nature of verbal ability by integrating findings and theories of cognitive psychology with those of differential psychology. The study included three kinds of measurements: an experimental faceted vocabulary test, reference ability tests, and a verbal exposure questionnaire. The faceted vocabulary test was used to study sources of difficulty in vocabulary test performance and how these sources of difficulty affect the relations between vocabulary tests and other ability measures.

The experimental task was a 3x3x3x2 faceted vocabulary test. The facets were word abstractness (concrete, medium, abstract), word frequency (low, medium, high), item type (vague recognition, accurate recognition, definition), and blocks (two parallel blocks). The item-type facet included two contrasts: definition vs. recognition items, and vague- vs. accurate-recognition items. The reference battery included tests of general mental ability, verbal ability, spatial ability, memory span, and closure speed. The verbal exposure questionnaire assessed frequency and time spent in reading, writing, doing homework, and viewing television. Subjects were 74 high school seniors selected to represent the bivariate distribution of verbal and spatial ability in a reference population of high school students.

The results indicated that vocabulary item difficulty increased with word abstractness, word infrequency, when item format required more precise word knowledge, and when the item required definition as opposed to recognition of the word. The results also suggested that partial concepts are prevalent in young adults and that word acquisition is a gradual process. Many words could be recognized vaguely but not accurately, or defined vaguely but not accurately, or recognized but not defined.

The following findings point to the role of reasoning processes in the acquisition or definition of words: a) some responses indicated that subjects could give correct examples of how the word was used in sentences but inferred incorrect defining features; b) students with low reasoning ability had major difficulties in the inference process during the definition stage; c) the reasoning composite related to vocabulary measures at the lower end of the vocabulary distribution but not at the higher end. This suggests that a certain level of reasoning ability is necessary for effective extraction of word meaning. Above this level, reasoning ability makes little difference in performance on vocabulary tests; d) vocabulary items that required the student to do more than merely recognize the correct meaning of a word had higher correlations with reasoning than recognition vocabulary items.

Verbal ability as represented by reading comprehension and reading vocabulary tests was best measured by frequent or medium-frequency words rather than by rare words. On the other hand, difficult recognition vocabulary tests such as advanced vocabulary tests seemed to measure mainly sources of difficulty due to infrequent words--sources that were related to individual differences in verbal exposure.

The results also suggest that students with poor verbal-sequential skills had particular difficulties with abstract words. Students with relatively little verbal exposure had particular difficulties with rare words, students with poor reasoning skills had major difficulties with definition items, and students with high spatial ability had an advantage in the acquisition or definition of concrete words. The roles of exposure and interest variables in the acquisition of vocabulary and other verbal knowledge were also discussed.

PREFACE

The investigation reported herein is part of an ongoing research project aimed at understanding the nature and importance of individual differences in aptitude for learning. Information regarding this project and requests for copies of this or other technical reports should be addressed to:

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TABLE OF CONTENTS

PREFACE iii

LIST OF TABLES vii

LIST OF FIGURES viii

Chapter

I INTRODUCTION 1

Current Approaches to Aptitude Process Research 2

Ability Organization 5

Complexity and the Verbal vs. Spatial Distinction 5

Complexity and Verbal Ability 6

Word Acquisition 7

Construct Validity of Vocabulary Tests and the Nature of Verbal Ability 10

Purposes of the Study 14

II METHOD 15

Subjects 15

Design 15

Experimental Task 15

Item type 15

Word frequency 18

Word abstractness 18

Blocks 18

Subjects 18

Reference Abilities 18

Verbal Exposure Questionnaire 19

Materials 20

Construction of the Experimental Task 20

Initial Selection of Words 20

Abstractness Rating 20

Construction of Recognition Items 21

Assignment of Items to Blocks 22

Definition Items 22

Procedure 22

III RESULTS AND DISCUSSION 24
Preliminary Analysis 25
Responses to Definition Items, and the Scoring System 25
Reliability of Scoring Definition Items 26
Construction of Factor Scores 27
Sources of Task Difficulty 28
Individual Differences in Experimental Task Performance 32
Validity and Reliability of the Experimental Task 32
Reasoning Ability and Vocabulary Knowledge 33
Memory Span, Spatial Ability and Vocabulary Knowledge 37
Word Difficulty and Verbal Ability 39
Ability x Facet Interactions 40
Memory span x word abstractness interaction 40
Reasoning ability x item type interaction 42
Word Acquisition as a Stochastic Process 46
Self-Report Variables 50
Intercorrelations Among Self-Report Variables 50
Correlations Between Self-Report Variables and Ability Measures 51
Some possible causal interpretations 51
Holistic vs. sequential processing 51
Vocabulary measures and exposure variables 54
Ability measures and interests 55

IV SUMMARY AND CONCLUSIONS 57
Method 58
Results and Discussion 58
Means Analysis 58
Word Acquisition as a Stochastic Process 59
Reasoning Ability and Vocabulary Knowledge 59
Memory Span, Spatial Ability and Vocabulary Knowledge . 61
Word Difficulty and Verbal Ability 61
Exposure Variables, Interests and Vocabulary Knowledge 62
REFERENCES 64
Appendix
A THE VERBAL EXPOSURE QUESTIONNAIRE 70
B INSTRUCTIONS TO RATERS OF WORD ABSTRACTNESS 75
C ITEMS IN THE EXPERIMENTAL TASK 77
D STATISTICAL APPENDIX 99
E CORRELATIONS BETWEEN ABILITY COMPOSITES AND PERFORMANCE ON THE VARIOUS LEVELS OF THE FACETED VOCABULARY TEST 102

LIST OF TABLES

Table

2.1 Examples of the Three Item Types 17

3.1 Summary of Analysis of Variance with Correctness as Dependent Variable 29

3.2 Percent of Words in the Various Knowledge States as Defined by Performance on Vague-Recognition, Vague-Definition, and Accurate-Definition Item Types for Low, Medium, and High Verbal Ability Students 47

3.3 Intercorrelations Among Self-Report Variables 51

3.4 Correlations Between Selected Self-Report Variables and Ability Measures 53

LIST OF FIGURES

Figure

2.1 Design of the experimental task 16

3.1 Plots of main effects and first-order interactions for the facets of the experimental task 31

3.2 Squared correlations between various vocabulary measures and reasoning, memory span, and spatial ability composites 34

3.3 Squared correlations between performance on concrete, medium, and abstract words and the spatial and memory span composites 38

3.4 Squared correlations between four verbal reference tests and words of low, medium, and high infrequency from the experimental task 41

3.5 The effect of definition on subsequent accurate-recognition of the same words as reflected in the performance of high, medium, and low reasoning subjects in the two accurate-recognition conditions 43

3.6 Plots showing the nonlinear relation between reasoning ability and various vocabulary aspects as reflected in small differences between highest third and medium third reasoning groups, and substantial differences between these groups and the lowest third group in performance on various levels of the faceted vocabulary test 45

CHAPTER I

INTRODUCTION

The present study investigates trait and process aspects of vocabulary knowledge and verbal ability. It contributes to an expanding field of research that seeks a cognitive process theory of mental abilities. This field, often referred to as "individual differences in cognition," or the study of "aptitude processes" (see, e.g., Snow, Federico, and Montague, 1980), combines elements from the two disciplines of differential and experimental psychology (Cronbach, 1957). Differential psychologists have traditionally emphasized the stability of individual difference traits across situations and regarded situational variation as unreliability, while experimental psychologists have emphasized situational or treatment variables that influence cognitive processes, regarding individual difference variance as error. A major aim of modern aptitude process research is to integrate trait and process perspectives in a more complete explanation of the kind of cognitive functioning reflected in performance on mental ability tests--to reach, in short, a theory of intelligence. Such a theory must include process-based descriptions of the mental abilities we take as constituents of intelligence as well as the interrelations among these abilities. It must also include trait-based descriptions of individual differences in these cognitive processes.

Vocabulary knowledge is a central construct in the trait description of verbal ability and in a process description of word and concept acquisition. Thus, both trait and process models must be integrated to understand individual differences in the acquisition, memory representation, and retrieval of vocabulary knowledge.

Since this is an aptitude process study that investigates trait and process aspects of vocabulary knowledge and verbal ability, this chapter presents several approaches to aptitude process research, and discusses trait and process aspects of cognitive abilities with particular emphasis on verbal ability and vocabulary knowledge. The chapter is divided into five sections.

The first section describes major approaches to aptitude process research as well as the approach of this study. The second section discusses trait aspects of cognitive abilities and their process interpretations. It concentrates on two major aspects of ability organization: test complexity, and the spatial vs. verbal distinction. The third section discusses process aspects of vocabulary knowledge as reflected in the processes involved in word acquisition. In the fourth section the trait and process aspects discussed in earlier sections are integrated in the discussion of construct validity of vocabulary tests, and the nature of verbal ability. The last section states the major purposes of this study.

Current Approaches to Aptitude Process Research

Cronbach and Snow (1977; see also Snow, 1977, 1978), in a detailed discussion of studies of aptitude x instructional treatment interactions (ATI), indicated the need for laboratory analysis of aptitudes. They argued that the study of individual differences in cognitive processes common to learning tasks and cognitive ability tests might contribute to resolving some of the puzzling inconsistencies among ATI findings in instructional research. For these and other reasons, there has been growing interest in recent years in the study of individual differences in cognitive processes. But several rather different methodological approaches have been used.

First, ability measures have been regressed onto experimentally obtained processing parameters, as demonstrated in work by Hunt, Frost, and Lunneborg (1973), Chiang and Atkinson (1976), and Snow, Marshalek, and Lohman (1976). In these studies, reference ability variables were correlated with parameters derived from tasks commonly used in experimental studies of cognitive information processing, such as Sternberg's (1969) memory scanning parameters or Neisser's (1967) visual search parameters. Correlational work of this sort seemed an obvious first step, since the process parameters were thought to be more basic and better understood theoretically than the ability constructs. However, this approach brought disappointments. The processing parameters seemed largely task specific; they showed only slight correlation with ability measures, particularly the more general ability measures. The generalizability and construct validity of these "basic" process parameters was questioned.

Second, eye movements and complementary subject introspections during ability test performance have been studied (see Lohman, 1977; Yalow & Webb, 1977; Snow, 1978, 1980). This seemed a fruitful way to detect strategy differences between low and high ability subjects. But the cost of eye movement recording is high, and the eye movement patterns do not necessarily display cognitive processes fundamental to performance success. Also, subjects' introspections about their own mental operations may be distorted and misleading. Strategy questionnaires may be used to support the eye movement records, and vice versa, but their combination remains an incomplete description at best.

Third, computer simulations of performance on ability tests have been constructed (see, e.g., Simon, 1976). While this approach has proved fruitful for understanding some of the general processes in problem-solving, simulation of all observable individual differences in the abilities involved in problem-solving has not yet been attempted. Some significant steps have been taken in the study of particular tasks (see Simon & Kotovsky, 1963; Kotovsky & Simon, 1973), but this is a far cry from what is needed.

Finally, componential analysis of ability tests, as demonstrated by Sternberg (1977, 1979a) has provided a comprehensive and powerful framework for the analysis of aptitude processes. In this approach, an ability task is broken down into components experimentally. The derived measures are assumed to reflect basic component processes common to many ability tests. These components parameters are correlated with external reference ability variables to establish external validity, and intercorrelated within the task to establish internal validity. Most componential studies face two major difficulties, however. Breaking a task into component parts experimentally can substantially alter the nature of the task (and therefore its correlations with other tasks), especially if this has the effect of simplifying ordinarily complex cognitive operations involved in whole task performance. Also, experimental division of a task into components according to the investigator's hypotheses about common processes may limit the number and kinds of strategies subjects are permitted to display, and may exclude executive, control, or other higher-order processes characteristic of truly able performance.

Despite these potential problems, the componential approach may be the most direct route to an understanding of cognitive process constituents of ability differences. A complementary line of work might circumvent some of these potential difficulties by changing emphasis from the molecular level of componential analysis to a more molar level. The methodology of this study reflects this change in emphasis. This methodology cannot be viewed as componential analysis as defined by Sternberg (1977). However, it is similar to componential analysis in that it combines task analysis with some kind of external validation.

This study included three kinds of measurements: an experimental task that was a faceted vocabulary test, reference ability tests, and a verbal exposure questionnaire. In the task analysis procedures the faceted vocabulary test was used to study the sources of difficulty (see Pellegrino & Glaser, 1980) in vocabulary test performance. In the external validation procedure, parameters from the experimental task were correlated with reference ability tests and verbal exposure variables, and inferences were made about the construct validity of vocabulary tests and other verbal tests. Two interrelated approaches were used in the external validation procedure. The first approach examined the differential effect of sources of difficulty represented by the facets of the experimental task on low and high ability students and made inferences about the information processing difficulties associated with being low on various abilities. The second approach examined the differential relations of various vocabulary aspects (levels of a facet) with ability composites and exposure variables, and made inferences about what is measured by these vocabulary aspects. The examination of these differential relations was also used to study how the various sources of difficulty in vocabulary test performance affect its relations with other ability measures.

These two approaches are closely interrelated. In most cases when there is a differential correlation of levels of a facet (in this study they are "vocabulary aspects") with an ability composite, there is also a correlation of the effect or contrast representing this facet with the ability. That is, the sources of difficulty represented by this facet differentially affect those that are high and low on the ability.

Ability Organization

Complexity and the Verbal vs. Spatial Distinction

Ability tests differ in many respects that might be of importance in influencing the intercorrelations among them (e.g., Guilford, 1967). However, the complexity dimension and the content facet appear to be the most predictive of the intercorrelations among mental tests (Guttman, 1954, 1965; Jensen, 1970; Marshalek, 1977). The complexity level of a test is defined as the apparent complexity of the mental operations involved in test performance (e.g., Guttman, 1954; Jensen, 1970; Marshalek, 1977). The content facet is most clearly revealed in factor analytic and scaling representations (e.g., Marshalek, 1977; Snow, 1978) as the distinction between tests requiring mainly verbal sequential processes and tests requiring mainly spatial analog processes. A third kind of content, arithmetical or numerical, can be viewed as requiring a combination of verbal sequential and spatial analog processing, or as emphasizing executive control processes and therefore being relatively independent of verbal or spatial contents.

The perceived complexity of a test closely approximates its actual correlation with _g_ (Jensen, 1970; Marshalek, 1977). Therefore, the complexity dimension may also be defined as an ordering of ability tests along a continuum according to their correlations with general ability, intelligence, the first principal component, or _g_. Complex tests such as Raven Matrices or Verbal Analogies show high correlations with _g_, while simple tests such as Memory Span, Perceptual Speed, or Visual Memory show only low or small correlations with _g_. It has been shown (Marshalek, 1977) that the vertical dimension in hierarchical models obtained from factor analyses parallels the dimension that radiates out from the center of the radex representation obtained from multidimensional scaling analyses—and that both represent the operationally defined complexity dimension, that is, the ordering of tests according to their loading on _g_.

"Complex" tests involve abstract problem-solving and inferential reasoning. Such tests appear to require the involvement of higher-order, central control processes or executive functions that identify the relevant relations in the problem and determine how to attack it, how to organize material in memory, and how to adapt the strategy to limitations in the cognitive system. On the other hand, "simple" tests seem more to tax the limitations of specific parameters, such as the speed of different kinds of processing components or different kinds of memory storage capacities. The specificity of the parameters taxed by such tests might account for the relatively low correlations among them.

The above discussion is consistent with Newell's (1973) emphasis on the notion of control processes as central to most cognitive tasks. As suggested above, the complexity dimension can be interpreted as the degree to which higher-order control processes are called for by the task. It also represents the degree to which the general factor rather than specific factors are implicated in test performance. In other words, higher-order control processes appear to be common to all cognitive tasks, and those that rely most heavily on control processes, such as reasoning tasks, measure functions common to all cognitive tasks, thereby defining the general factor *g*.

The process interpretations of the complexity dimension and the content facet are used in later chapters to discuss the role of higher-order control or reasoning processes and sequential and analog processes in vocabulary test performance.

Complexity and Verbal Ability

Verbal tests can be found all along the complexity dimension, from central to peripheral regions of the radex model, or from lower to higher levels of the hierarchical model. Most complex verbal tests are tests of verbal reasoning, such as verbal analogies, verbal classification, etc. These are usually regarded as measures of *g* or general reasoning, rather than measures of verbal ability, since they correlate highly with nonverbal abstract reasoning tests such as Raven Matrices and Necessary Arithmetic Operations. The latter are usually taken as measures of spatial-figural reasoning and numerical reasoning, respectively (Thurstone, 1938; Marshalek, 1977). Together, verbal, figural, and numerical reasoning tests are taken to define *g*.

Verbal tests of intermediate complexity usually fall into a factor called "verbal comprehension" (French, Ekstrom, Price, 1963) or "verbal ability" (Thurstone, 1938; Carroll, 1941), a factor most often defined by vocabulary tests. Carroll (1941) saw this factor as the ability to learn various conventional linguistic responses and to retain them over long periods of time. He suggested that the factor represents differences in the stock of linguistic responses possessed by the individual--the wealth of the individual's past experience and training in the English language. French et al. (1963) called the factor "verbal comprehension," representing the ability to understand the English language. Tests loading on this factor demand understanding of sentences, idiomatic phrases, and grammatical patterns.

Most simple verbal tests show rather low correlations with g; they probably reflect specific factors such as fluency of expression, ideational fluency, ability to name objects rapidly, associative learning, and memory. These tests thus probably measure speed of encoding or retrieval, or specific memory parameters.

Word Acquisition

Rips, Shoben, and Smith (1973) distinguish network from set-theoretic models of semantic memory representation. Network models assume that words or their conceptual counterparts exist as independent units in semantic memory that are connected in a network by labeled relations. In contrast, in the set-theoretic models, concepts are represented by sets of semantic components. These components might be attributes, names of subsets or supersets, images of exemplars, or some mixture of these various components. Hollan (1975) has shown that the set-theoretic model presented by Smith, Shoben & Rips (1974) can be formulated as a network model without loss of explicatory power.

The two kinds of models seem to be complementary for the purpose of modeling the acquisition of new words. The network models imply that the words (nodes) get their meaning from the network of relations in which they appear. The network of relations is formed by many sentences encoded into propositions the person heard or read in the past. On the other hand, the set-theoretic models imply that an active process of abstraction of attributes (semantic features, semantic components, etc.) takes place. This view is consistent with traditional theories of concept learning.

Comprehensive models of semantic memory use propositions to represent knowledge, and most of the propositional systems are networks that consist of links and nodes. According to Anderson and Bower (1973), Long Term Memory (LTM) can be viewed as a conceptual network which serves as a data base. The basic elements of LTM are concepts and relations between concepts. The meaning of a concept is given by the configuration of its relations to other concepts. Learning a new fact is a matter of recording its representation, establishing its specific configurations of relations among already known concepts. Thus, the meaning of a sentence or proposition is determined by the concepts embedded in it. On the other hand, the meaning of the concept is determined by the propositions in which it has been embedded in the past.

This description seems consistent with the way new words are learned by adults. New words appear to be learned from the context in which they appear, rather than by memorizing definitions. That is, words get their meaning from the way they have been used in sentences. People may have difficulties defining a word but they can often tell how the word is used. Also, as they try to define a word, they report attempts to retrieve different propositions in which the word has been embedded in the past. Thus, when trying to define a word, people presumably infer the defining features of the word from their semantic network.

This process of inferring semantic features can take place in LTM without explicit requirements to define words. The impression is strong that words are learned by a gradual increase in the number of semantic components attached to the word in LTM, a process emphasized by Clark (1973) in her model of semantic acquisition in children. The process of inferring word meanings from contexts in which they were embedded might take place in three stages: during the input, during organizational processes in LTM, and during output, e.g., when producing a definition.

During the input stage, certain propositions are encoded (e.g., relations of the "is a," "has a" type) that are actually inferences about the meaning or semantic features of the new word. In LTM, new inferences can be made about the meaning of the word by a process of induction on the encoded propositions that are related to the new word. This can be viewed as a process of solving a set of equations (propositions) for a few unknowns (semantic features). During the definition or output stage, inference of the defining features from the semantic network in which the word is embedded is called upon explicitly.

This process of inferring the meaning of the word from the context in which it was embedded is hypothesized to be the key factor responsible for the strong relationship of vocabulary knowledge to reasoning abilities and general intelligence. Individuals who are high in reasoning and inference ability have an advantage in this process of inferring the meaning of words from context. They can infer more propositions of the form "is a" or "has a" during the input stage than low reasoning ability individuals. They are also better at inferring new semantic features from existing networks in LTM, or during the process of defining a word.

There appear to be three major subject variables involved in word acquisition: a) Extraction--the ability to infer or extract word meaning from the context in which it was embedded; b) Memory and retention abilities--the ability to retain or retrieve words, their meanings, and their propositional contexts; c) The amount and range of past exposure to verbal materials.

The suggestion that extraction, memory, and amount of exposure are the major subject variables involved in word acquisition and concept learning is based on diverse lines of study. Most theories of concept formation and word acquisition emphasize the importance of the process of abstraction or inference of critical attributes from instances and noninstances of the concept (e.g., Carroll, 1964; Flavell, 1970; Nelson, 1974). It has been demonstrated by most studies that the number of exposures to the instances and noninstances is a major factor in concept learning. The same is true for the acquisition of words from contexts or sentences in which they appear. The more exposure one has to the word, the higher the probability of acquisition. The importance of the memory or retention component in concept formation is emphasized in a study and review (Dunham, Guilford, & Hoepfner, 1968) in which concept formation tasks varying in content (figural, symbolic, and semantic) were correlated with various ability factors. Memory abilities showed a consistently positive relation to task scores.

Construct Validity of Vocabulary Tests and the Nature of Verbal Ability

There is a tendency to misperceive what vocabulary tests measure. Sternberg (1979b) suggested that "sometimes it is not obvious what tests measure. Vocabulary tests, for example, may well measure something more than the number of words a person has learned" (p. 47). Estes (1974) stated that "The ubiquitous vocabulary test . . . is similar to the digit span test . . . in the deceptively simple appearance of the task" (p. 745). While discussing the Wechsler intelligence scales, Jensen (1980) presented the following apparent paradox:

> The scores on the vocabulary subtests are usually the most highly correlated with total IQ of any of the other subtests. This fact would seem to contradict Spearman's important generalization that intelligence is revealed most strongly by tasks calling for the eduction of relations and correlates. Does not the vocabulary test merely show what the subject has learned prior to taking the test? How does this involve reasoning or eduction? (pp. 145-146)

In other words, vocabulary tests appear deceptively simple. In spite of the simple appearance of the task, empirical evidence, such as their high correlations with complex reasoning tests and measures of _g_ (e.g., Marshalek, 1977), suggest that they are "complex."

The previous discussion of word acquisition might shed light on the source of this misperception. It was suggested that a major part of the individual differences variance in vocabulary test performance is due to processes that occurred during the word acquisition stage. Vocabulary tests, especially those of the multiple choice variety, appear deceptively simple since, as we respond to them, we are not aware of the complex reasoning processes (of extracting word meaning from context) that took place in the past. This also might explain the tendency to perceive vocabulary tests as measuring mainly the _present_ size of a _structure_ in LTM (the number of words the person has learned) rather than _past processes_ involved involved in word acquisition.

The process of word acquisition described earlier, and the suggested explanation of the high correlation of vocabulary tests and reasoning, are consistent with the hypotheses of other investigators. Sternberg (1979b) reported that he and Powell were investigating the following hypothesis:

> Vocabulary tests provide an indirect measure of a person's ability to acquire the meaning of words from their context: from conversation, reading, or whatever. Some people seem better able than others to absorb meanings from context. It is this important ability--which we believe is a major aspect of intelligence--that vocabulary tests may measure indirectly. (p. 47)

Jensen (1980) suggested the following:

> Vocabulary tests are among the best measures of intelligence, because the acquisition of word meanings is highly dependent on the eduction of meaning from the contexts in which the words are encountered. . . . Children of high intelligence acquire vocabulary at a faster rate than children of low intelligence, and as adults they have a much larger than average vocabulary . . . because they are capable of educting more meaning from single encounters with words. (p. 146)

Even though vocabulary tests have high correlations with the general factor *g* and with reasoning tests, their highest correlations are with other complex verbal tests. In addition to the general factor *g*, vocabulary tests measure something that is shared by other complex verbal tests that is specific to verbal ability. Verbal ability is psychometrically defined by complex verbal tests that measure language comprehension and word knowledge. Verbal ability or the Verbal Comprehension factor is most often defined by vocabulary tests (French et al., 1963). Other tests loading on this factor demand understanding of sentences, idiomatic phrases, and grammatical patterns. This factor also closely approximates Horn and Cattell's (1966) crystallized intelligence or Gc factor.

It is suggested that verbal ability is effectiveness and facility in creating and operating on semantic networks, in particular facility in extracting concept (or word meaning) from context, and understanding context (e.g., sentence) from the concepts embedded in it. The former aspect of verbal ability is measured by vocabulary tests and most directly by reading vocabulary tests that demand understanding of how a word is used in context. The latter aspect is measured by reading comprehension tests. These two aspects of verbal ability are closely interrelated not just correlationally. The process of understanding how a word is used in context (or the process of extracting concept from context), and the process of understanding context from concepts are similar processes that operate in opposite directions: concept from context vs. context from concept. Both processes take place during discourse comprehension and are essential to discourse comprehension, and therefore understanding how a word is used in context can also be viewed as part of sentence comprehension.

The interdependence of these two processes is also implicit in network models of semantic memory. Comprehending a sentence is a matter of recording its representation, establishing its specific configuration of relations among already known concepts. On the other hand, the meaning of a concept is determined by the propositions in which it has been embedded and that were recorded during the process of sentence comprehension. Therefore word or concept acquisition skills depend on sentence comprehension skills and vice versa.

Anderson and Freebody (1979) suggested that the causal interpretation for the correlations between vocabulary tests and measures of verbal comprehension cannot be restricted to one possibility. They discussed three possible interpretations. They view the interpretation that vocabulary and reading comprehension tests both measure verbal ability or verbal aptitude as the most fully developed. Another interpretation they discussed was that some students have better text comprehension than others because they know more words. They suggested that this interpretation is inconsistent with some recent evidence where, for instance, researchers were unable to increase comprehension of text that contained many difficult words by direct instruction on these words. The third interpretation suggested that vocabulary and reading comprehension tests reflect extent of exposure to the culture, and knowledge of the culture. This interpretation reminds us that most verbal tests measure crystallized ability (Cattell, 1963) that is reflected in current memory or knowledge structures, that in turn reflect an investment of ability or aptitude in education and verbal experience. In other words, most verbal tests measure current knowledge that reflects crystallization of aptitude and experience. This hypothesis is consistent with the previous suggestion that vocabulary tests measure current knowledge (number of words the person has learned) that reflects verbal aptitude or efficacy of past processes (word acquisition) as well as extent of verbal exposure.

While some verbal tests (such as recognition vocabulary and general information tests) measure mainly current knowledge, other verbal tests (such as definition vocabulary or reading comprehension) measure, in addition, complex processes that take place during test performance. Another common aspect measured by verbal tests (as distinct from spatial tests), is the ability to deal with sequential information. This may account for their relation with simple tasks requiring sequential processing (such as memory span tasks).

The view of the nature of verbal ability expressed here differs from that of Hunt and his associates (Hunt et al., 1973; Hunt, Lunneborg & Lewis, 1975; Hunt, 1978). The view of verbal ability expressed here emphasizes higher-order control processes that are meaning-related (semantic), as reflected in context-from-concept and concept-from-context processes. In contrast, Hunt and his associates emphasize simple elemental and mechanistic processes, such as decoding speed, for the understanding of verbal ability. However, the two views can be seen as complementary rather than contradictory. For instance, the rate of knowledge and word acquisition might depend in part on speed of elemental and mechanistic processes. Of particular interest is Hunt's (1978) suggestion that high verbal ability people grasp the meaning of sentences faster than other people. This was supported by studies indicating that high verbal ability subjects comprehend simple sentences faster than low ability subjects.

Finally, there are various aspects of vocabulary knowledge. Cronbach (1942, 1943) and Estes (1974) have both stressed the need to distinguish and investigate aspects of vocabulary knowledge such as precision of word knowledge, recognition vs. definition, etc. This study investigates several aspects of vocabulary knowledge and makes inferences about the construct validity of vocabulary tests by examining the differential relations of these aspects to ability measures and verbal exposure variables.

Purposes of the Study

The major purpose of this study was to investigate trait and process aspects of vocabulary knowledge and verbal ability that might lead to a better understanding of the construct validity of vocabulary tests and the nature of verbal ability. A faceted vocabulary test was used to study sources of difficulty in vocabulary test performance, and how these sources of difficulty affect the relations between vocabulary tests and other ability measures. Inferences about what is measured by various vocabulary aspects were made by examining the differential correlations of vocabulary aspects (levels of a facet) with ability measures and verbal exposure variables. Inferences about the information processing difficulties associated with being low on various abilities were made by examining the differential effect of the sources of difficulty represented by the facets of the vocabulary test on low and high ability students. Of particular interest were the effects of these sources of difficulty on the complexity of vocabulary tests, and on the extent to which they measure verbal sequential processes as opposed to spatial analog processes.

Specifically, it was predicted that the difficulty of vocabulary items would be affected by word characteristics as well as by aspects of item format. Vocabulary item difficulty should increase with word abstractness and word infrequency. Vocabulary item difficulty should increase also when item format requires more precise word knowledge, and when the item requires definition as opposed to recognition of the word. It was hypothesized that vocabulary items requiring complex output processes such as definition would have higher relations with reasoning than recognition items. It was hypothesized that concrete word items would have higher relations with spatial ability than abstract word items.

CHAPTER II

METHOD

Subjects

Subjects were 35 male and 39 female high school seniors who participated as paid volunteers. They were selected from a reference population of 241 California high school students who had taken a large reference battery of ability tests (see Snow et al., 1977). Most of these students had participated in other studies conducted by the Aptitude Research Project at Stanford University. Of the original 241 students, 130 were still available at the time of the present study. The sample was selected to represent the bivariate distribution of verbal ability and spatial ability in the reference population.

Design

The study included three kinds of measurement: the experimental task, the reference ability tests, and the verbal exposure questionnaire.

Experimental Task

The experimental task was a 3x3x3x2 faceted vocabulary test. The design of the task is shown in Figure 2.1. All of the experimental manipulations were within-subject facets. These are described in the sections below.

Item type. The item-type facet had three levels: vague-recognition items, definition items, and accurate-recognition items. In vague-recognition items, distractors were unrelated semantically to the correct answer. Therefore, knowledge of just one semantic feature of the word in the item stem would suffice to answer such an item correctly. On the other hand, in accurate-recognition items, distractors were semantically related to the correct answer (both of which were in the form of short definitions). Thus, knowledge of just one semantic feature would usually not suffice to answer the item correctly. In other words, accurate-recognition items put more demand on concept accuracy, or concept completeness, than did vague-recognition items (see example items, Table 2.1).

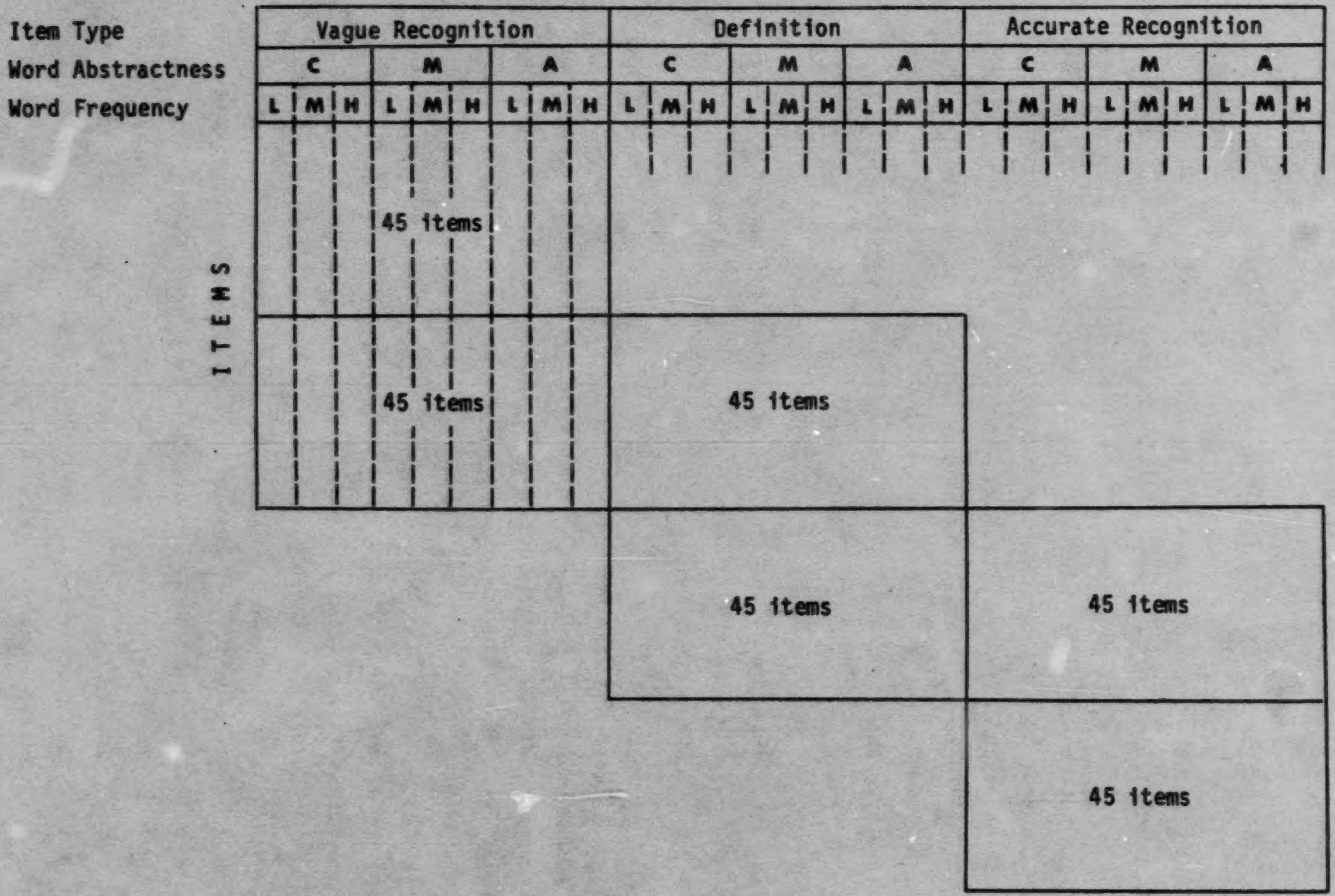
Item Type
Word Abstractness
Word Frequency
Vague Recognition
Definition
Accurate Recognition
C
M
A
L
M
H
ITEMS
45 items
45 items
45 items
45 items
45 items
45 items

Figure 2.1. Design of the experimental task.

Table 2.1

Examples of the Three Item Types

Vague Recognition	Accurate Recognition	Definition
1. laudable a. out loud b. able to see c. praiseworthy d. in debt	1. gale a. a very strong wind b. a heavy burst of rain c. a storm with lightning and rain d. a flood caused by rain	INSTRUCTIONS: On the next page there is a list of words. Your task is to write out the meanings. Use a synonym if you can, but also explain each word even if you can give a synonym. For example:
2. banquet a. small bank b. a British sport c. hot coals d. elaborate feast	2. anvil a. a hammer for shoeing horses b. an instrument for cutting metal c. a mold for shaping metal d. a block for shaping metal	1. breakfast — The first meal of the day. 2. conceal — Hide. Keep from view. 3. enormous — Huge. Exceeding the usual size.
		1. adroit
		2. mitigate

The item-type facet included two contrasts: a production contrast to compare definition vs. recognition items, and an accuracy contrast to compare vague vs. accurate-recognition items.

Word frequency. The word-frequency facet had three levels: low, medium, and high frequency. Infrequent words were chosen to have a frequency of less than three per million (and mostly one and two per million) according to the Thorndike-Lorge (1944) G-Count. The medium words had a frequency of three to eight per million, and the frequent words had a frequency of more than nine per million (mostly between 9 and 19).

Word abstractness. The word-abstractness facet had three levels: concrete, medium, and abstract. Words were rated on the concreteness-abstractness dimension using the Spreen and Schulz (1966) procedure. See p. 21 for details of the abstractness rating procedure, and Appendix B for instruction to raters of word abstractness.

Blocks. There were two blocks for each of the three levels of item-type (see Figure 2.1). Words in the top and bottom blocks appeared only once in the design. Words in the other blocks were repeated twice, first in the definition condition and then in one of the recognition conditions.

There were five words (items) within each of 54 cells of the 3x3x3x2 design in Figure 2.1. Therefore, each block consisted of 45 words varying in word frequency and word abstractness. All the 45 words that appeared in the top definition block were repeated in the bottom vague-recognition block. All the words that appeared in the bottom definition block were repeated in the top accurate-recognition block. Thus, words were nested within the facets of the design. However, half of the words were crossed with one of the contrasts in the item-type facet.

Subjects. Subjects constituted the fifth facet, completely crossed with the other design facets. Order of administration of blocks and the order of items were held constant for all subjects.

Reference Abilities

Tests that define general mental ability, verbal ability, spatial ability, memory span, and perceptual speed had been previously administered to all subjects. These tests included the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1955), a number of group tests from the Kit of Reference Tests for Cognitive Factors (French et al., 1963), and also subtests of the Comprehensive Test of Basic Skills (CTBS; McGraw-Hill, 1973). In addition, the Advanced Vocabulary Test (French et al., 1963), a fairly difficult multiple-choice vocabulary test, was administered at the time of this study. For a more detailed account of the reference tests, see Snow et al. (1977).

Verbal Exposure Questionnaire

The verbal exposure questionnaire was included as an attempt to assess past exposure to verbal materials in various media, and to investigate how verbal exposure variables relate to vocabulary knowledge and to specific vocabulary components. It was designed according to a faceted definition of the universe of observations (Guttman, 1970). The two major facets in the design were media (books, newspapers, magazines, television, movies) and specificity of behavior (specific behavior versus general habits). For instance, questions about specific behavior asked students to list all books they had read during the previous month, or to list all TV programs they had watched. On the other hand, questions about general habits asked about the amount of time per week spent reading books, or the number of books read per month.

The original mapping sentence for the design observations was: the amount of verbal exposure of student (x) through media (books, newspapers, magazines, television, movies) in the (past, present) was studied through questions about (specific behavior, general habits) in terms of (listing specific activities, time spent per week, frequency of activities). First, an attempt was made to generate at least one question for each of the cells of the 5x2x2x3 design. Then, some questions were omitted, others were modified, and still others were added to tailor the questionnaire to the purposes of the study, and to obtain more valid responses from the students. The final version of the questionnaire is reproduced in Appendix A.

Materials

Construction of the Experimental Task

The vocabulary task was constructed in three stages. First, a large pool of words was selected from the three word frequency ranges. These were rated on abstractness-concreteness and divided into concrete, medium, and abstract categories. Finally, three types of items were constructed: vague-recognition items, accurate-recognition items, and definition items.

Initial Selection of Words

The first stage attempted to establish three ranges of word frequency that would constitute appropriate levels of difficulty for high school seniors. After this was established, a larger pool of words, about 700, was selected from the Thorndike and Lorge (1944) list and from high school textbooks. Every effort was made to avoid words that had more than one commonly used meaning, were technical (e.g., concepts in cooking or auto mechanics), or were more common in speech than in reading (words with a frequency index thought to be misleading).

Abstractness Ratings

Words were rated on the concreteness-abstractness dimension using a procedure by Spreen and Schulz (1966; see Appendix B). About 500 words were rated by five graduate students. Raters were allowed to use a dictionary while performing the ratings. The instructions to the raters are presented in Appendix B. The reliability of the ratings was established by three methods: the coefficient of generalizability, Cronbach's Alpha (considering raters as "items" and words as "persons"), and the mean intercorrelation among raters, corrected by Spearman and Brown. The same reliability estimate of .88 was obtained by each method.

Ratings for each word were then summed across the five raters to give a concreteness-abstractness score ranging from 7 for very concrete words to -7 for very abstract words. Words in the 3 to 7 range were assigned to the concrete category, words in the -3 to -7 range were assigned to the abstract category, and words in the range -1 to 1 were assigned to the medium category. Words for which raters showed considerable disagreement were dropped from the sample.

The three levels of abstractness and three levels of frequency formed a 3x3 design of abstractness by frequency. Since both word abstractness and word frequency were continuous variables, words were also distributed on frequency and abstractness within each of the nine cells of the design. To insure that the design was orthogonal, the variability of words on abstractness was equated for all cells of the same level of abstractness. The same procedure was used for word frequency. Words from each of the nine cells were then assigned randomly to four groups with similar distributions on frequency and abstractness. These groups were then used for the construction of two blocks of vague-recognition items and two blocks of accurate-recognition items.

Construction of Recognition Items

In all recognition items, the alternatives were easier than the word in the item stem. This insured that the difficulty of recognition items was not affected by the difficulty of words used in either the correct answers or distractors.

Irrelevant clues to correct answers were avoided. On the other hand, irrelevant clues were used constructively to make all distractors attractive and plausible to subjects who lacked the essential information.

In vague-recognition items, distractors were unrelated semantically to the correct answer. Therefore, knowledge of just one semantic feature of the word in the item stem would suffice to answer such an item correctly. On the other hand, in accurate-recognition items, distractors were semantically related to the correct answer (both of which were in the form of short definitions). Thus, knowledge of just one semantic feature would usually not suffice to answer the item correctly. In other words, accurate-recognition items put more demand on concept accuracy, or concept completeness, than did vague-recognition items.

Assignment of Items to Blocks

Vague-recognition items were assigned randomly to two parallel blocks. Each block consisted of 45 items in a 3x3 design of frequency by abstractness, with five items within each of the nine cells. The two blocks were comparable with respect to the frequency and abstractness distributions of words within each cell. The same procedure was applied to accurate-recognition items to create two parallel accurate-recognition blocks. Words used in one of the vague-recognition blocks were used to create one definition block, and words used in one of the accurate-recognition blocks were used in a second definition block (see Figure 2.1). The six blocks in the design were comparable with respect to internal design of abstractness by frequency.

Items within blocks were ordered from easy to difficult, to minimize frustration and to give students successful experiences before encountering difficult items. Blocks of items were issued as paper and pencil subtests (see Appendix C).

Definition items

In definition blocks, students were encouraged to attempt to define a word even if they had only partial knowledge of the word. Also, they were asked to attempt to find a synonym for every word. Examples were provided of acceptable definitions and acceptable synonyms.

While the scoring system for definition items was modeled after the vocabulary subtest of the WAIS, definition blocks differed from the WAIS Vocabulary scale in two respects. First, in the definition blocks, students wrote their answers in response to the printed word. In the WAIS, the subject interacts with the tester verbally. Second, in the definition block, students were explicitly asked to define the words, and were given concrete examples of acceptable answers. In the WAIS, the subject is asked to tell the tester the meaning of the word, and is not provided examples of acceptable answers.

Procedure

The vocabulary blocks, the verbal exposure questionnaire, and a multiple-choice Advanced Vocabulary test (French et al., 1963) were administered to small groups of about 15 subjects. Sessions lasted two and one-half hours. Students were allowed as much time as they needed to complete the tasks and check their answers. They were encouraged to try to answer every item for which they had at least partial knowledge. Random guessing was discouraged. The order of administration of tasks and items was held constant for all subjects. The order of administration of tasks was: upper vague-recognition block (see Figure 2.1), lower definition block, verbal exposure questionnaire, upper definition block, lower accurate-recognition block, lower vague-recognition block, upper accurate-recognition block, Advanced Vocabulary test. Words that were repeated twice appeared in a definition block before they appeared in a recognition block. The questionnaire and vague-recognition blocks were the easiest tasks and therefore were used as a warm-up at the beginning of the session, or were interspersed among the more difficult definition and accurate-recognition tasks. Ordering of blocks and tasks also insured that definition and recognition blocks in which words were repeated were separated by other blocks.

CHAPTER III

RESULTS AND DISCUSSION

This chapter is divided into six sections. The first section presents examples of subjects' responses to the definition items, emphasizing common mistakes that imply partial knowledge or partial concepts. These examples and the discussion of partial knowledge are then used to define the scoring system. Next, the procedures used to construct scores representing different aspects of performance on the experimental task and the formation of ability factor scores are described. The second section presents a means analysis of the experimental task, and discusses the effects of the experimental facets in terms of sources of difficulty in vocabulary test performance. The third section reports the analyses of individual differences in the experimental task performance. It examines how several sources of difficulty in vocabulary test performance affect the relations of vocabulary tests with other ability measures. Inferences about what is measured by various vocabulary aspects are made by examining the differential correlations of vocabulary aspects (levels of a facet) with ability measures. Inferences about the information processing difficulties associated with being low on various abilities are made by examining the differential effect of the sources of experimental task difficulty on low and high ability students. The fourth section suggests that word acquisition can be viewed as a stochastic process in which words are continuously moving from an unlearned state through one or more partial knowledge states into a learned state. The administration of the faceted vocabulary test is viewed as taking a picture of the process at a certain point in time. This section also examines the distribution of words in the various knowledge states, and how this distribution differs among students depending on their abilities. The last section examines the relations among verbal exposure variables and interests, as well as the relations of these variables with vocabulary and other ability measures. It discusses the contributions of exposure variables and interests to individual differences in vocabulary knowledge.

Preliminary Analyses

Responses to Definition Items, and the Scoring System

The scoring system for the definition items combined the scoring procedure for the WAIS Vocabulary subtest and the distinction between vague- and accurate-recognition items. An accurate definition was a definition indicating that the student had an accurate concept, or knew the primary semantic features of the word. A vague definition indicated only partial knowledge of the concept represented by the word. Wrong definitions were definitions that the student did not have even partial knowledge of the word.

The distinction between vague and accurate definition was central to the scoring system. In the WAIS, an accurate definition is a response that includes one or more definitive or primary features, or several correct descriptive features, which, while not precisely definitive, do cumulatively indicate understanding of the word. An accurate synonym is also accepted. On the other hand, a vague definition includes one primary feature that by itself is insufficient, or attributes which are correct but not definitive. A vague or inexact synonym is also regarded as a vague definition. Some vague definitions are responses that include only one primary feature where two conjunctive features are required. For example, a common vague definition, given by young children in response to the word "winter" in the WAIS, is the mention of season alone or of cold alone. Similarly, in the case of the word "slice," mention is made of "piece" or "making into parts" without the implication of thinness (Wechsler, 1955).

Many of the vague definitions given by subjects in this study were similarly incomplete. A common response to "bison" was "an animal"; or to "capillary"--"a blood vessel" (without the implication of smallness); or to "granite"--"a rock"; or to "venison"--"meat"; or to "retort"--"a response." In the case of words such as "granite," any correct descriptive feature in addition to the primary feature (a rock) qualified the response as accurate.

In other instances, response included one correct primary feature and another incorrect feature, such as "Japanese garment" for toga, or "meat of a snake" for venison, or "a main blood vessel" for capillary. In these instances, the student demonstrated knowledge of one primary feature (such as garment, meat and blood vessel) and so the response was scored as partial knowledge or vague definition rather than as incorrect. In some instances of vague definition, the response was too specific to be considered accurate—such as "to scratch" in response to the word "mar"—and was scored as partial knowledge.

Some responses indicated that the student knew at least one context in which the word was used but extracted the wrong features. That is, the student gave a correct example of how the word is used in a sentence but gave a wrong definition. Such a response did not receive credit since the ability to repeat a word in a sentence heard in the past only means that the student was exposed to the word, not that any meaning or semantic features were extracted.

Two scores were constructed for each of the definition items, the Accurate Definition score (AD) and the Vague Definition score (VD). An item was given an AD score of "1" if the word was defined accurately, and "0" if it was not defined accurately. An item was given a VD score of "1" if it was defined vaguely or accurately (partial knowledge or accurate definition) and a score of "0" if it was defined incorrectly or was not defined at all. Thus, the VD and AD scores were experimentally dependent for the definition items. A definition that received an AD score of 1 necessarily received a VD score of 1. But a definition that received an AD score of 0 could receive a VD score of either 0 or 1.

Only one score was constructed for each of the recognition items. Each item was scored as "1" if it was answered correctly and "0" otherwise. As before, the five item scores within each cell were added to form cell scores.

Reliability of Scoring Definition Items

Analyses used either individual item scores or cell scores as the unit of analysis. The five item scores within each cell were summed to make the cell score. Therefore, scorer reliability estimates were computed separately for item level and cell level scores.

The reliability of scoring by individual scorer of the AD score was .88 for the item level and .92 for the cell level. For the VD score, these values were .95 and .97, respectively. However, the final scoring was based on the independent scoring of two scorers and their discussion of items on which they had disagreed. This scoring by the two scorers was highly reliable. The reliability of the AD score was .94 at the item level and .96 at the cell level. Here, for the VD score, coefficients were .97 and .98, respectively.

Construction of Factor Scores

Factor scores or composite scores were constructed to estimate verbal and quantitative achievement, general, verbal, spatial, memory span, and perceptual speed abilities.

Verbal achievement was estimated by the centroid of three verbal subtests of the Comprehensive Test of Basic Skills (CTBS): Reading Vocabulary, Reading Comprehension, and Language Expression. Quantitative achievement was estimated by the centroid of the Arithmetic Concepts, Arithmetic Applications, and Arithmetic Computation subtests of the CTBS. Verbal ability was represented by the centroid of five measures: Verbal achievement and the Vocabulary, Information, Comprehension, and Similarities subtests from the WAIS. The centroid of six complex spatial tests (Paper Folding, Surface Development, Form Board, Hidden Figures, WAIS Block Design, and WAIS Object Assembly) represented spatial ability. Two simple spatial subtests from the WAIS, Picture Completion and Picture Arrangement, were not included in this estimate. Memory span was estimated from three tests: Auditory Letter Span, Visual Number Span, and WAIS Digit Span. The perceptual speed score came from four tests: Number Comparison, Finding A's, Identical Pictures, and WAIS Digit Symbol. (Tests not identified as WAIS or CTBS were taken from French et al., 1963.)

Three alternative estimates for general mental ability were used: WAIS total IQ, the centroid of all tests, and an estimate of reasoning ability. The latter was represented by a centroid of five measures, including four reasoning tests and quantitative achievement. The reasoning tests were: Raven Advanced Progressive Matrices (Raven, 1962), a subset of Verbal Analogies from the Terman Concept Mastery Test (Terman, 1950), Necessary Arithmetic Operations (French et al., 1963), and a letter series test adapted from Simon and Kotovsky (1963) who in turn had adapted it from Thurstone (1938). These tests are referred to in subsequent discussion as Raven, Verbal Analogies, Necessary Arithmetic Operations, and Letter Series, respectively. The three estimations of general ability were highly intercorrelated. WAIS IQ correlated .92 with the centroid and .85 with the reasoning composite. The latter two dimensions correlated .92.

The nonorthogonality of the estimated factors is representative of the hierarchical structure of human abilities. General ability or reasoning ability is the most general, verbal ability and spatial ability are of intermediate generality, and perceptual speed and memory span are relatively specific factors.

Quantitative achievement was included in the reasoning ability composite since it included arithmetic reasoning tests that were found to be central to the reasoning composite. Verbal achievement was included in the verbal ability composite since it correlated highly with the other verbal tests in the composite. This verbal ability composite closely approximates Horn and Cattell's (1966) crystallized intelligence or Gc factor. Horn and Cattell's (1966) fluid intelligence or Gf factor is operationally the same as the reasoning ability or general mental ability composite defined here, although Horn and Cattell interpret the factor somewhat differently. Finally, the spatial ability composite is synonymous with the Horn and Cattell (1966) general visualization or GV factor.

Sources of Task Difficulty

A repeated measures analysis of variance on correctness, using cell scores as the unit of analysis, is shown in Table 3.1. The table also includes estimates of variance components and the percent of variance associated with each source. Blocks were treated as replications, yielding two replications per cell. This analysis included only the accurate-definition score for definition items, since the accurate-definition and vague-definition scores were not experimentally independent. Item type, frequency, and abstractness facets were treated as fixed effects; subjects and blocks (replications) were treated as random effects.

Main effects accounted for most of the variance. Many

Table 3.1

Summary of Analysis of Variance with Correctness as Dependent Variable

Source	df	MS	F	$\hat{\sigma}^2$[a]	pct.[b]
Mean	1	49,364.87	-	-	-
Item Type(I)	2	638.46	400.26*	.48	17.6
Frequency(F)	2	533.31	332.48*	.40	14.7
Abstractness(A)	2	251.85	162.27*	.19	6.9
IF	4	22.78	33.34*	.05	1.8
IA	4	1.34	2.33	0	.1
FA	4	33.87	39.35*	.07	2.7
IFA	8	14.78	29.47	.10	3.5
Subjects(S)	73	28.48	36.80*	.51	18.8
SI	146	1.60	2.06*	.05	1.7
SF	146	1.60	2.07*	.05	1.7
SA	146	1.55	2.00*	.04	1.6
SIF	292	.68	.88	0	0
SIA	292	.57	.74	0	0
SFA	292	.86	1.11	.01	.5
SIFA	584	.50	.65	0	0
Residual	1,998	.77	-	.77	28.4

[a] Estimated variance component

[b] Percent of total variance

* = p less than .01

interactions were significant but accounted for relatively little variance. A strong general factor accounted for most of the individual differences variance in the task. This is indicated by the size of the subject main effect relative to the size of the subject-factor interactions. In other words, individual differences generalized over the task facets. Nevertheless, all first-order subject-factor interactions were statistically significant.

The main effects and some of the first order interactions were plotted in Figure 3.1. Note that the dependent variable is percent of incorrect responses rather than percent correct. Percent incorrect directly reflects task difficulty, and the design facets can easily be interpreted as sources of task difficulty. Note that vague-definition score appears for comparison purpose in Figure 3.1a, 3.1d, and 3.1f even though it was not included in the analysis of variance.

Vocabulary task difficulty increased with word abstractness and word infrequency. That is, abstract words were more difficult than concrete words and infrequent words were more difficult than frequent words. Vocabulary task difficulty was also substantially affected by item type. In Figure 3.1a the item type facet was represented as a 2x2 design of production by accuracy. Definition items were more difficult than recognition items. The effects of the accuracy factor were similar for recognition and definition items.

The significant word abstractness by word frequency interaction in Figure 3.1e shows that these facets enhance each other's effects on word difficulty. Frequent words that were also concrete were extremely easy, while infrequent words that were abstract were extremely difficult.

There was some indication that the difficulty of abstract words was due mainly to the input or acquisition stage rather than the definition or output stage. In other words, the difficulty of abstract words seemed not to be due to difficulty in defining them, but rather to difficulty in acquiring them. If performance on vague-recognition items reflects mainly past acquisition processes while performance on definition items reflects past acquisition plus present output processes, then the substantial abstractness effect within vague-recognition items (Figure 3.1d) indicates that a least part of the

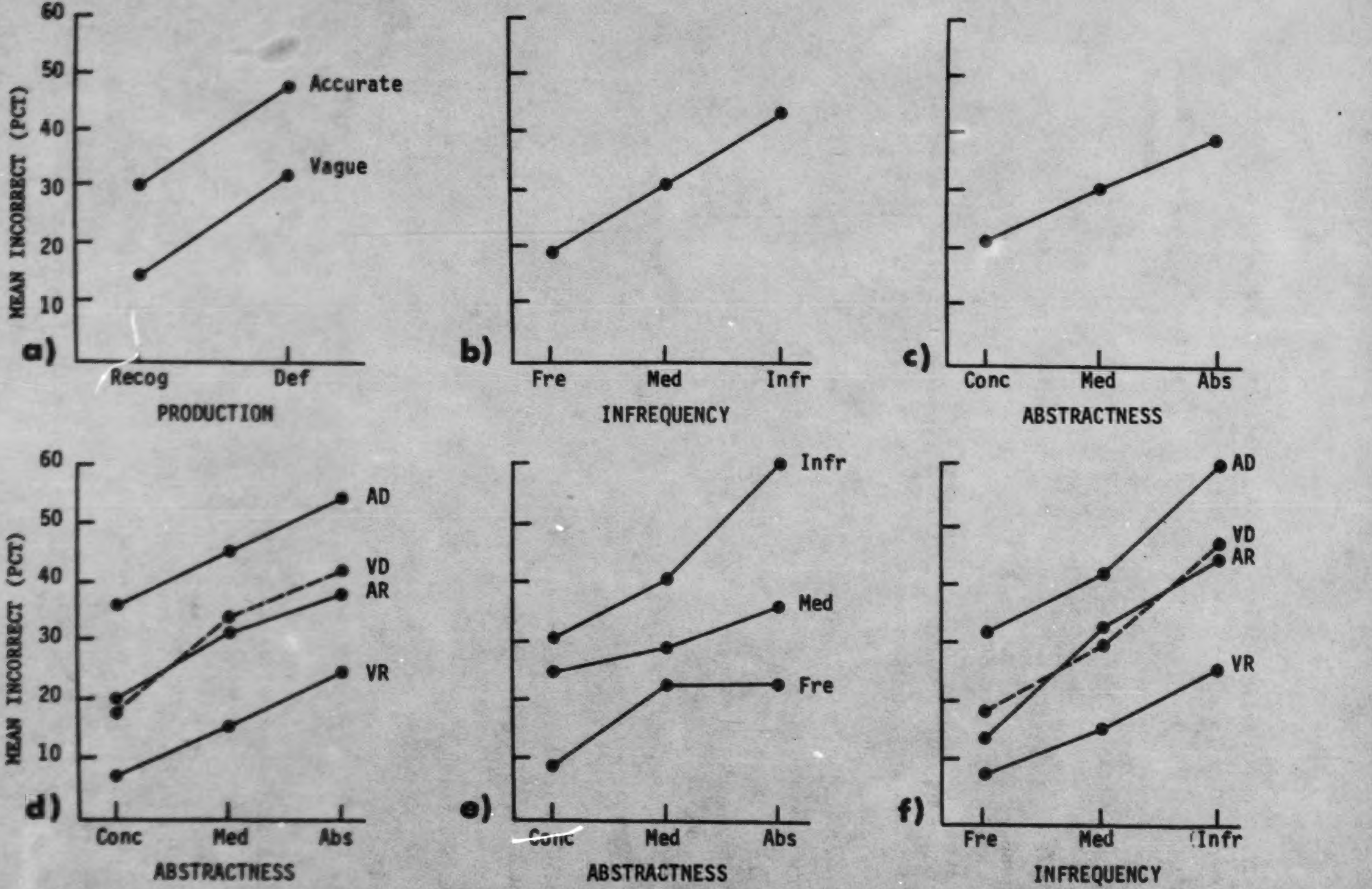

Figure 3.1. Plots of main effects and first-order interactions for the facets of the experimental task. AD, VD, AR, and VR represent Accurate Definition, Vague Definition, Accurate Recognition and Vague Recognition.

difficulty of abstract words was due to difficulties in the acquisition stage. The fact that the abstractness effects were of similar magnitude within vague-recognition and definition items (Figure 3.1d) indicates that little if any of the difficulty of abstract words was due to the definition or output stage. If the abstractness effect was a result of a combination of difficulty in the acquisition and definition stages, then the effect of abstractness should have been stronger in definition items than in recognition items.

Individual Differences in the Experimental Task Performance

This section addresses some of the major questions of the study concerning the construct validity of vocabulary tests: What is measured by vocabulary tests? Why are such tests central to verbal ability (or crystallized intelligence) and reasoning (or general intelligence)? Why are they related to spatial ability and memory span? What is measured by the various aspects of vocabulary tests?

These questions are examined by studying the ability-facet interactions and the differential relations of the various vocabulary aspects with the ability composites. In most cases when there is a different correlation of levels of a facet with an ability, there is also a correlation of the contrast representing this facet with the ability. That is, the source of difficulty represented by this facet differentially affects those high and low on the ability (ability-facet interaction).

Adding or deleting a source of difficulty to a task changes its relations with the ability depending on whether the source of difficulty is relevant to the ability in question.

Validity and Reliability of the Experimental Task

Before examining the other results it is necessary to establish that the experimental task measured what it was intended to measure and did so reliably. The total score (number correct) on the experimental task correlated .87 with WAIS Vocabulary, .85 with Advanced Vocabulary, and .87 with CTBS Reading Vocabulary. Clearly, the experimental task measured the same construct as other vocabulary tests. Among the ability composites, the total score had the highest correlation with the verbal composite (r = .86), followed by reasoning (r = .70), memory span (r = .49), space (r = .36), and perceptual speed (r = .20). Note that the reasoning composite was also an estimate of general mental ability in this battery. Another estimate of general ability was WAIS IQ which correlated .67 with the total score. Clearly the experimental task can be viewed as a measure of verbal ability or general crystallized intelligence.

Furthermore, various subscores in the experimental task gave correlation patterns with the ability composites that were similar to their corresponding external vocabulary tests. This is shown in Figure 3.2, where squared correlations between the various vocabulary measures and three ability composites are plotted. The external recognition test (Advanced Vocabulary) had the same pattern of correlations with the ability composites as the recognition blocks that did not follow definition. The WAIS Vocabulary (a definition test) had the same pattern of correlations with the composites as the definition scores of the experimental task (an exception is the higher correlation of accurate-definition score with memory span that will be discussed later).

A counter explanation for these results is that the correlation patterns reflect differences in reliability for the four Item Type scores. However, the four Item Type scores had high reliability coefficients. Cronbach's Alpha for the vague-recognition, accurate-recognition, vague-definition and accurate-definition scores were .93, .92, .96, and .95 respectively, and their parallel forms reliability estimates were .90, .92, .96, and .96 respectively. Thus, differences in correlation patterns cannot be explained by differences in reliability.

Reasoning Ability and Vocabulary Knowledge

What aspects of vocabulary knowledge are responsible for its relation with reasoning or general intelligence? It has been argued that vague-recognition items measure mainly input or past acquisition and retention processes, while definition items measure in addition output or definition processes that take place during word definition. It has also been assumed that three subject variables contribute to the

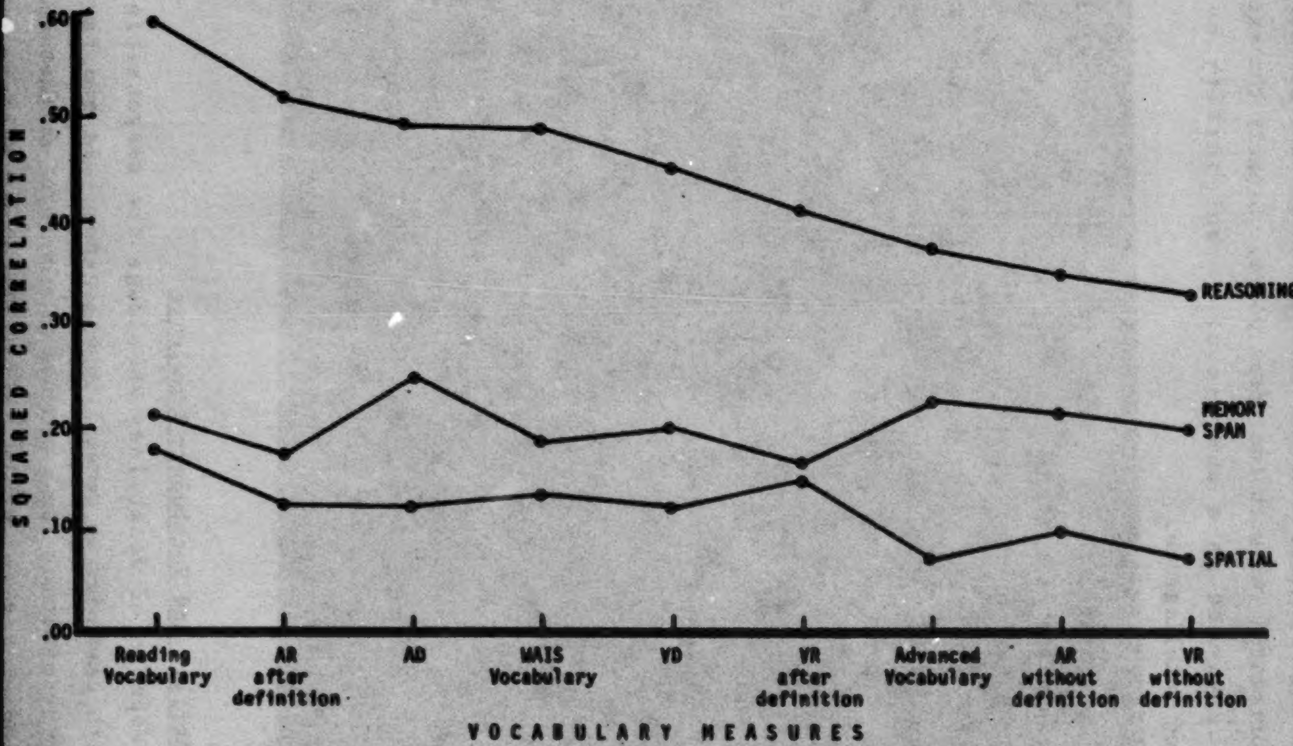

Figure 3.2. Squared correlations between various vocabulary measures and reasoning, memory span, and spatial ability composites. AR, AD, VD, and VR represent Accurate Recognition, Accurate Definition, Vague Definition, and Vague Recognition.

variation among individuals on word knowledge: a) the ability to extract word meaning from context, b) amount of past exposure to the word, c) retention or memory abilities. It was suggested that ability to extract word meanings from context (or the ability to define words) is the ability that is responsible for the relation between vocabulary knowledge and reasoning, since defining a word and inferring word meanings from context require complex reasoning and problem-solving processes. On the other hand, retention ability and amount of past exposure contribute individual differences variance to vocabulary test performance that is unrelated to reasoning, and this reduces the relation between vocabulary tests and reasoning. Therefore one can expect vocabulary measures that rely less on retention abilities and past exposure and more on output processes to have high correlations with reasoning. On the other hand, vocabulary tests that do not measure output processes should have lower correlation with reasoning since a substantial portion of their variance is attributed to variation in past exposure and retention. Thus, it can be expected that Reading Vocabulary will have particularly high relation with reasoning since it puts less demand on memory by supplying the student with the word in context, and requires that the student determine how the word is used in the particular context. Vague-recognition items are expected to have the lowest relation with reasoning since they do not measure output processes, and so a substantial portion of their variance should depend on past exposure and retention.

The plot in Figure 3.2 is consistent with these expectations. Reference tests and item-type scores from the experimental task were ordered along the abscissa in Figure 3.2 according to their correlations with the reasoning composite. Note that this ordering also corresponds with their perceived complexity and the hypothesized involvement of output processes in each test or item type. Further, there were substantial differences in the correlations of various vocabulary measures with reasoning. While 59 percent of the variance in Reading Vocabulary was accounted for by the reasoning composite, only 33 percent of the variance in vague recognition (without definition) was explained by the reasoning composite. Within the experimental design, blocks of items that measured definition processes had higher relations with reasoning than blocks that did not. Vague-definition and accurate-definition items had significantly ($p < .05$) higher correlations with reasoning than vague-recognition-without (see significant tests in Appendix D and correlation matrix in Appendix E).

Recall that words in the two recognition-without-definition blocks (vague-recognition-without-definition and accurate-recognition-without-definition) appeared only once in the design while words in the recognition-after-definition blocks (vague-recognition-after-definition and accurate-recognition-after-definition) appeared twice, first in the definition condition and then in one of the recognition conditions. The correlational patterns in Figure 3.2 suggest that the recognition-after-definition blocks measure some of the definition processes that took place earlier in the definition condition. Recognition-after-definition items showed consistently different patterns of correlation with the ability composite than recognition-without-definition items. Further, recognition-after-definition blocks had patterns of correlation with ability composites similar to those of the definition measures and the WAIS Vocabulary, while recognition-without-definition blocks had patterns similar to those of a reference recognition test, Advanced Vocabulary. Recognition-after-definition blocks involved more reasoning than recognition-without-definition blocks. In particular, accurate recognition after definition correlated higher with reasoning than accurate recognition without definition ($p < .05$; see Appendix D). There was also a trend (although statistically nonsignificant) for the recognition-after-definition blocks to correlate higher with the spatial composite and lower with memory span composite than recognition-without-definition blocks.

There was a consistent trend, shown in Figure 3.2, for the various accuracy measures (accurate recognition after definition, accurate definition, and accurate recognition without definition) to correlate higher with the reasoning composite than their respective "vague" measures (vague recognition without definition, vague definition, and vague recognition after definition). However, this effect was relatively small, suggesting that response accuracy does not add substantially to the relation of vocabulary tests to reasoning. Further, word abstractness did not add to the relation of vocabulary with reasoning. Concrete and abstract word items had similar correlations with reasoning.

Memory Span, Spatial Ability and Vocabulary Knowledge

This section concerns the question of what aspects of vocabulary tests are responsible for their relation with spatial ability and memory span.

It was suggested that the degree to which a task calls for holistic or spatial-analog processes as opposed to verbal-sequential processes is highly predictive of the intercorrelations among cognitive tasks. In spite of a strong general factor in intelligence tests, simple holistic-spatial tests tend to be uncorrelated or have low negative correlations with simple sequential tasks like memory span tests, suggesting some antagonism between sequential and analog processes.

Introspective reports of subjects suggested that spatial-analog processes were involved in the solution of concrete word items. Students reported retrieving prototype images of words while solving concrete word items but not while solving abstract word items. For the solution of abstract word items, students seemed to rely entirely on sequential processes. Therefore, it might be expected that concrete word items would show higher correlations than abstract word items with tasks that involve spatial-analog processes. On the other hand, abstract word items would be expected to show higher correlations than concrete word items with tasks involving simple sequential processes.

The results shown in Figure 3.3 were consistent with these expectations. Concrete word items had significantly higher correlations with spatial ability than did abstract word items ($p < .05$; see Appendix D). On the other hand, abstract word items had significantly higher correlations with memory span than concrete word items ($p < .05$; see Appendix D).

Spatial ability measures may relate to vocabulary tests for two reasons. First, both vocabulary tests and complex spatial tests require reasoning. Second, spatial-analog processes are involved in the acquisition and retrieval of concrete words. This may be the reason that some simple spatial tests, such as WAIS Picture Completion,

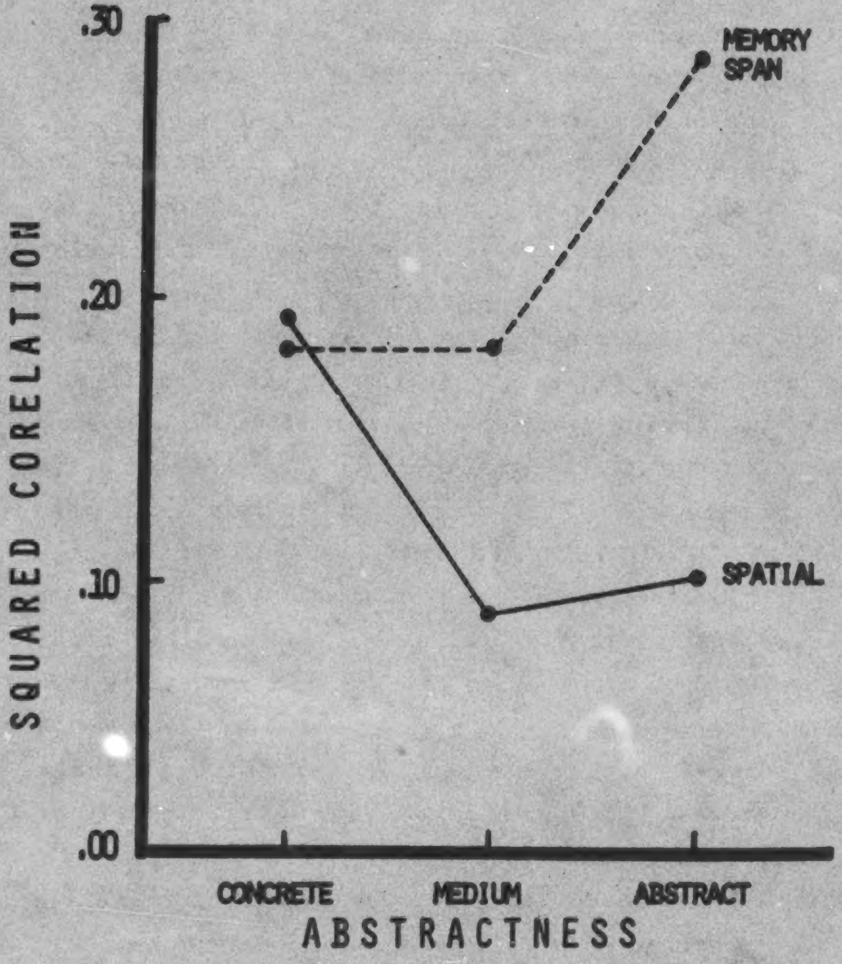

Figure 3.3. Squared correlations between performance on concrete, medium, and abstract words and the spatial and memory span ability composites.

often relate to vocabulary tests. Here, about 20 percent of the variance in concrete word items and 10 percent of the variance in abstract word items was accounted for by spatial ability. When arithmetic reasoning (as measured by the quantitative achievement composite) was partialled out of spatial ability (using part or semi partial correlations), only 10 percent of the variance in concrete words and one percent in abstract word items was accounted for by spatial ability (see Appendix D). In other words, abstract word items related to spatial ability primarily because complex spatial tests measure reasoning. However, concrete word items related to spatial ability even when reasoning was partialled out, probably because spatial-analog processes are involved in solving concrete word items.

While high spatial ability is advantageous for vocabulary test performance, a preference for holistic processing style as opposed to sequential processing might be disadvantageous when defining words. The number of vague definitions given by students did not correlate with general, verbal or spatial ability tests (all of these correlations were negative and close to zero) but it was positively correlated with what Das, Kirby, and Jarman (1979) would call holistic style measures and negatively with tests they would call sequential processing measures. Students who had most difficulty giving accurate definitions (i.e., they gave many vague definitions) were students who performed well on closure speed tests ($r = .28$, $p < .05$), spent more time than average watching television ($r = .36$), reading comic books ($r = .36$) and magazines ($r = .31$), but not newspapers. They had difficulties in sequential processing as represented by memory span ($r = .35$) and strongly disliked English classes ($r = .45$). Inaccuracies in definitions thus appeared to be associated with a tendency toward holistic processing and difficulties in sequential processing.

Word Difficulty and Verbal Ability

It has been assumed that verbal ability is efficiency in building and operation on semantic networks; in particular, it is the ability to extract concepts (or word meanings) from context, and to understand context (e.g., sentences) from concepts embedded in it. The ability to understand how a word is used in context was measured in this study by a reading vocabulary test. The ability to understand context from concepts embedded in it was measured by a reading comprehension test. Figure 3.4 suggests that verbal ability as represented by reading comprehension and reading vocabulary is best measured by frequent or medium-frequency words rather than by rare words. On the other hand, recognition tests of vocabulary such as advanced vocabulary tests seem to measure sources of difficulty due to word infrequency--sources that are not central to verbal ability. Frequent words are words to which everyone has been exposed; failing to comprehend them must result mainly from failure to extract accurate meanings during acquisition or definition stages, rather than from lack of exposure. Thus, frequent and medium-frequency words provide better measures of verbal ability than do rare words, since they reflect more of the ability to extract word meaning from context during acquisition and definition stages, and less of variation in exposure.

Ability x Facet Interactions

Previous sections examined the differential relations of various vocabulary aspects (levels of a facet) to ability composites, and made inferences about what is measured by these vocabulary aspects. This section examines the differential effect of the sources of difficulty represented by the facets of the experimental task on low- and high-ability students, to make inferences about the information-processing difficulties associated with being low on various abilities.

These two approaches are closely interrelated. In most cases when there are different correlations of performance with an ability for different levels of a facet (in this study they are "vocabulary aspects"), there is also a correlation of the effect or contrast representing this facet with the ability. That is, the sources of difficulty represented by this facet differentially affect those that are high and low on the ability. The following examples may clarify this distinction.

Memory span x word abstractness interaction. It was suggested in previous sections that spatial-analog processes are involved in the solution of concrete word items, but not in the solution of abstract word items where the student must rely primarily on sequential

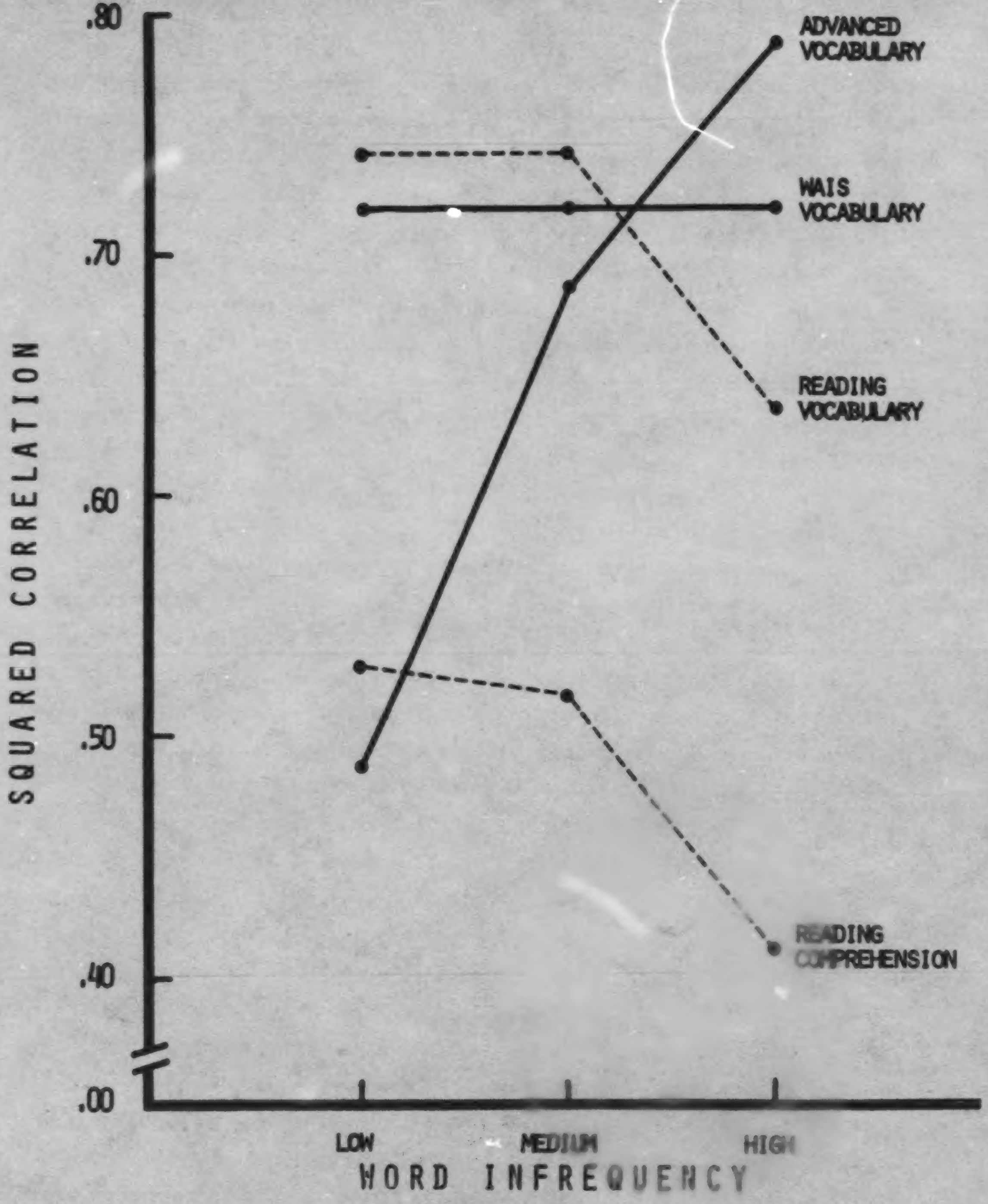

Figure 3.4. Squared correlations between four verbal reference tests and words of low, medium, and high infrequency from the experimental task.

processes. The supporting evidence for the suggestion that abstract word items measure sequential processes more than do concrete word items was that abstract word items had significantly higher correlation with sequential processing tasks (i.e., memory span) than concrete word items. The focus of analysis in the present section is the degree to which difficulty due to abstract words affects more students with low memory span scores than students with high memory span scores. Plots of individual student data suggest that students with low memory span scores had more difficulty with abstract words relative to other words than did students with higher memory span scores. This outcome was also reflected by correlations between the contrasts representing the sources of difficulty due to abstract words relative to other words with the memory span composite. The abstractness linear contrast (number correct on abstract word items minus number correct on concrete word items) correlated .41 ($\underline{p} < .05$) with the memory span composite, and the contrast of high-abstractness words vs. medium-abstractness words correlated .34 ($\underline{p} < .05$) with the memory span composite. These contrast-ability correlations suggest that students with low memory span scores have more difficulty with abstract words relative to concrete and medium abstractness words than students with high memory span scores. In other words, the contrast-ability correlation provides a measure of the magnitude of the effect, and a test of significance for the trends that are evident in the plots of individual subjects data.

Reasoning ability x item-type interaction. In some cases the plots of ability x facet interaction add substantially to the interpretation of the results. This is the case for the reasoning ability x item-type interaction. It was suggested earlier that accurate recognition after definition involves more reasoning than accurate recognition without definition, probably because the recognition-after-definition items reflect some of the definition processes that took place earlier in the definition condition. The plots in Figure 3.5 shed some more light as to why recognition after definition measures reasoning ability more than recognition without definition. The performance of high reasoning ability students improved on accurate-recognition items as a result of defining the

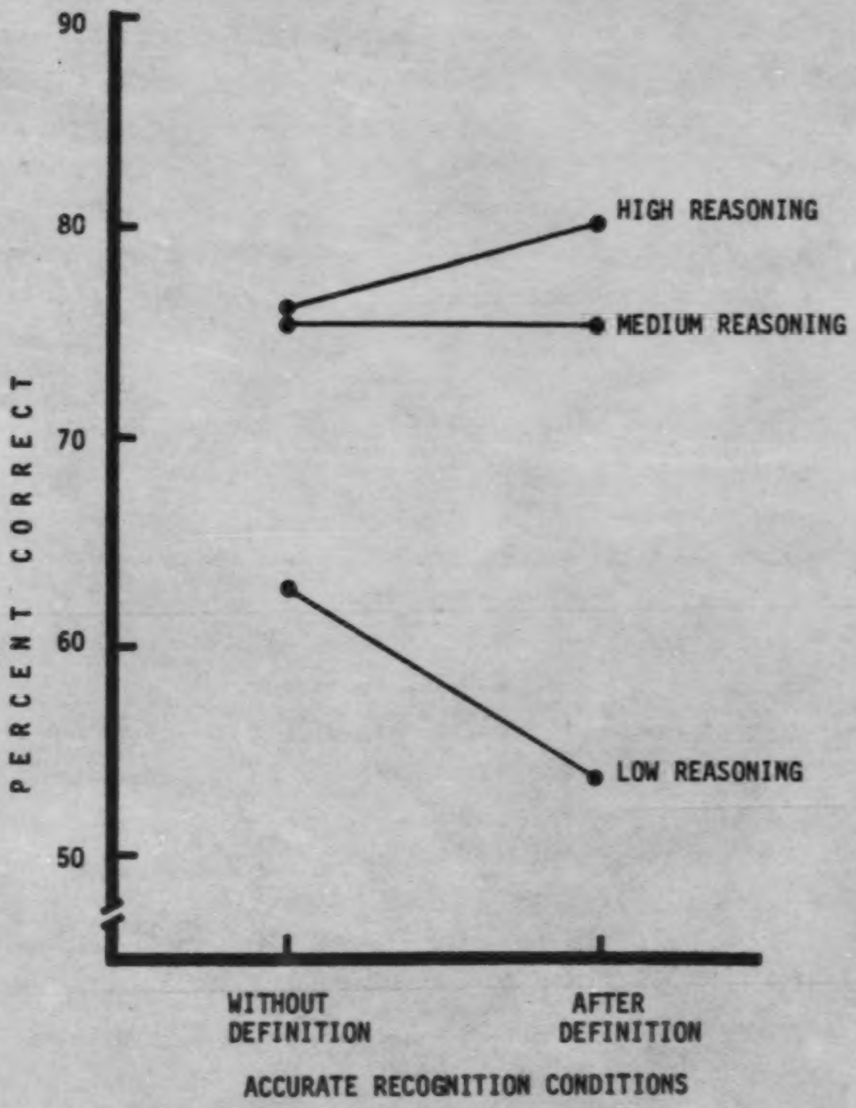

Figure 3.5. The effect of definition on subsequent accurate recognition of the same words as reflected in the performance of high, medium, and low reasoning subjects in the two accurate recognition conditions.

words, while the performance of low reasoning students became worse. Perhaps some learning and inference processes take place during definition which involve inferences about defining features from the semantic network. Low reasoning students may have made more wrong inferences during the definition condition that interfered with their subsequent performance on recognition items. On the other hand, high reasoning students perhaps made mostly correct inferences during definition that were helpful during subsequent performance on recognition items. In other words, the recognition-after-definition items measure some reasoning or inference processes that took place during definition performance. These processes are not measured by recognition when it does not follow definition.

The above effect in accurate-recognition items also occurred in the vague-recognition items but to a smaller extent. This is probably because vague-recognition items are less sensitive to wrong inferences about semantic features that occurred during the definition condition. The contrast of accurate-recognition items without definition vs. after definition (number correct on accurate recognition without definition minus number correct on accurate recognition after definition) correlated -.45 ($\underline{p} < .05$) with reasoning. On the other hand, the contrast of vague-recognition items without definition vs. after definition correlated only -.27 ($\underline{p} < .05$). These results suggest that first defining the word had only a small effect on subsequent performance in the vague-recognition condition but had a substantial effect on subsequent performance in the accurate-recognition condition.

Students with low reasoning skills appear to have major difficulties in inferring correct defining features from their semantic network. Further evidence concerning their difficulties with extracting word meaning from context (either in the acquisition stage or the definition stage in which the context is the semantic network) is provided by the implied nonlinear relations between reasoning ability and the various vocabulary aspects (item types) in Figure 3.6. Note that the performance of high-reasoning students (highest third) was not significantly better than that of the medium group (medium third), on the various vocabulary aspects, but the performance of both groups was substantially superior to that of the low reasoning group

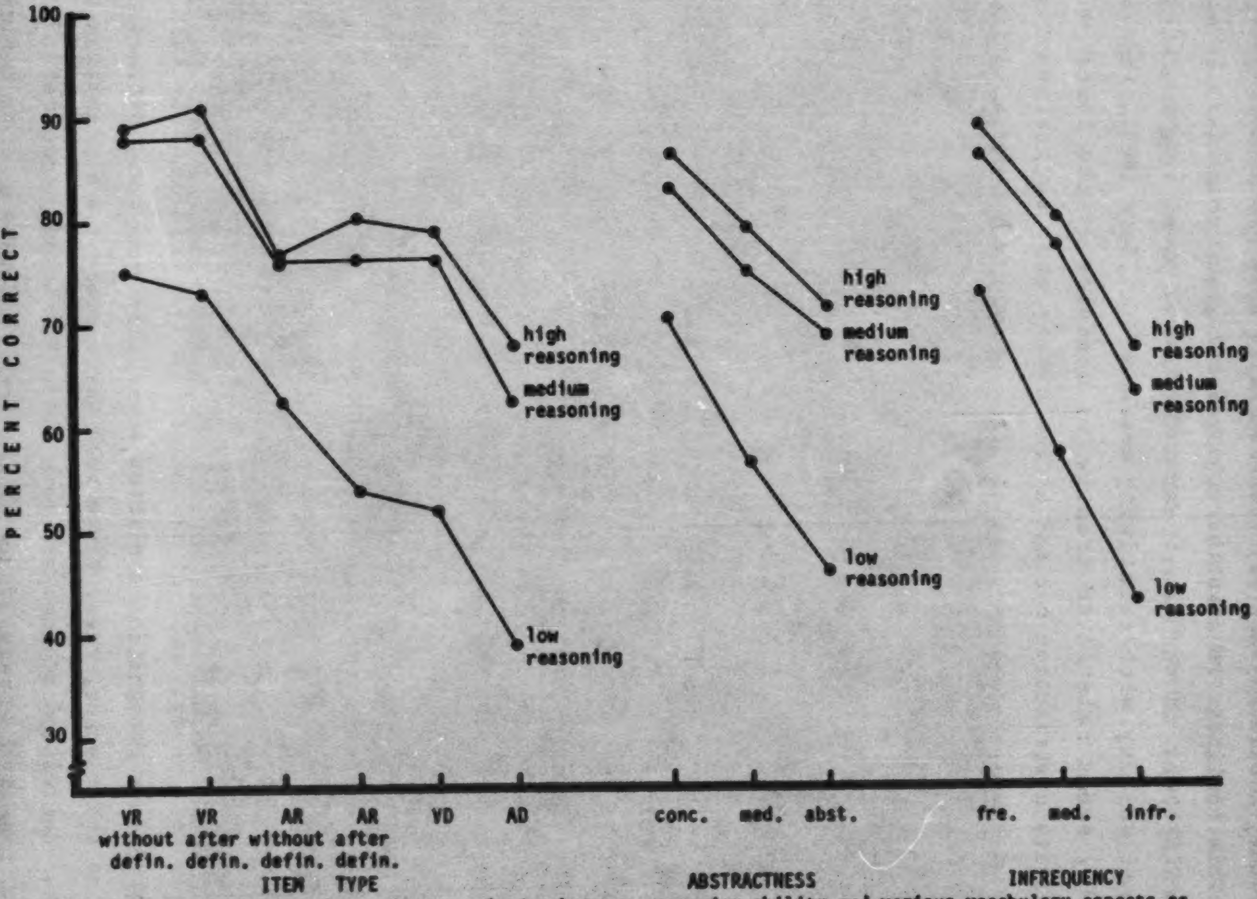

Figure 3.6. Plots showing the nonlinear relation between reasoning ability and various vocabulary aspects as reflected in small differences between highest third and medium third reasoning groups, and substantial differences between these groups and the lowest third group in performance on various levels of the faceted vocabulary test. VR, AR, VD, and AD represent Vague Recognition, Accurate Recognition, Vague Definition, and Accurate Definition.

(lowest third). This implies that a certain level of reasoning is necessary for efficient extraction of word meaning. Above this level, reasoning ability makes little difference in performance on such tasks, and other skills that are more specific to verbal ability and vocabulary knowledge such as retention skill take precedence.

This nonlinear relation between reasoning and vocabulary knowledge is reminiscent of the nonlinear relation of reasoning ability or general ability with creativity measures (Guilford 1967). Reasoning ability seems related to creativity measures at the lower end of creativity distribution but not at the higher end, suggesting that a certain level of reasoning ability is a necessary but not a sufficient condition for high scores on creativity measures. This nonlinear relation of reasoning or general ability with other tasks might also account for the frequent finding of a stronger general factor in lower ability groups (such as younger age groups) than in higher ability groups.

Word Acquisition as a Stochastic Process

The process of word acquisition can be viewed as a stochastic process in which words are continuously moving from an unlearned state through one or more partial knowledge states into a learned state, as a functioning of repeated exposures to the words in contexts (i.e., sentences). The administration of a vocabulary test is rather like taking a picture of the process at a certain point in time. For a particular student, some words are in an unlearned state, some are in partial knowledge states, and others are in a learned state. The distribution of words in the various states differs among students depending on their exposure to the words, their ability to extract word meaning from context, and their retention abilities.

In this study, half of the words in the experimental task were repeated in a recognition condition after they were first defined. For each of these words, then, there were three scores: a recognition score and two definition scores: accurate definition and vague definition. These repeated observations on the same word were used to define the learning state of each word for a particular student (see Table 3.2). If the student could neither define the word nor recognize it, the word

Table 3.2

Percent of Words in the Various Knowledge States as Defined by Performance on Vague-Recognition, Vague-Definition, and Accurate-Definition Item Types, for Low, Medium, and High Verbal Ability Students.

State	Item Type[a]			Verbal Ability			
	VR	VD	AD	Low	Medium	High	Mean[b]
Unlearned state	-	-	-	24	10	3	12
Partial knowledge states							
Recognition but no definition	+	-	-	23	16	8	16
Recognition with partial definition	+	+	-	13	12	11	12
Learned state	+	+	+	36	59	76	57
Anomalous states							
No recognition with partial definition	-	+	-	1	1	0	1
No recognition with accurate definition	-	+	+	3	2	2	2

[a] Passing item represented by "+", failing item by "-".

[b] Numbers represent percent of the words in each knowledge state.

was assumed to be in the unlearned state. If the student could recognize the word and could define it accurately, the word was assumed to be in the learned state. A word was assumed to be in partial knowledge states if the student could define the word vaguely but not accurately, or if the student could recognize the word but could not define it.

As can be seen in Table 3.2, on average, 12 percent of the words that were repeated in the vague-recognition and the definition conditions were in the unlearned state, 57 percent were in the learned state, and 31 percent were in partial knowledge states. Of the 31 percent of the words in partial knowledge states, 12 percent were recognized and defined vaguely but not defined accurately, 16 percent were recognized but not defined correctly.

The anomalous states in Table 3.2 are states that are inconsistent with a Guttman scale. A model that assumes that recognition is a necessary but not sufficient condition for definition assumes a perfect Guttman scale. With the exception of three percent of the words, words that were defined correctly were also recognized correctly. The conditional probability of correctly recognizing a word once it was defined correctly was .96. Further, occurrences of anomalous state words can be attributed to instances in which the student knew and could define one (usually a more rare) meaning of the word, but did not know the meaning used in the recognition item (usually the most widely used meaning). These results are consistent with the assumption that definition includes all the processes of recognition plus some additional processes. While vague-recognition items measure mainly processes that took place during the acquisition or input stage, definition items measure, in addition, processes that take place during the output or definition stage.

The substantial number of words in partial knowledge states, and the examples of partial definition discussed earlier, suggest that partial concepts are prevalent in young adults, and that word acquisition is a gradual process.

The number of words in partial knowledge states correlated negatively with ability composite scores, indicating that low ability students showed more words in partial knowledge states than high ability students. For instance, the number of words that were recognized correctly but not defined correlated negatively with verbal, reasoning, memory span, and spatial ability composites: -.65, -.49, -.36 and -.23 respectively. The number of words that could be defined vaguely but not accurately correlated negatively with memory span ($\underline{r}$ = .35), but did not correlate with reasoning, verbal and spatial ability composites. An estimate of the number of words that could be recognized vaguely but not accurately was negatively correlated with verbal, reasoning, and memory span ability composites: -.41, -.34, and -.24 respectively. This estimate was derived by subtracting the number of items answered correctly in the accurate-recognition condition from the items answered correctly in the vague-recognition condition.

The results in Table 3.2 are consistent with the above correlations. The fact that the number of partial definitions did not differ between low and high verbal ability students (lowest third and highest third) is reflected in the absence of a correlation between the verbal ability composite and the number of partial definitions. On the other hand, the substantial difference between high and low verbal ability students with regard to number of words in the other partial knowledge state (recognition but no definition) was reflected in the correlation of -.65 between verbal ability and the number of words in this state.

The results reported above were restricted to words that were repeated in definition and vague-recognition conditions, since first defining the words had only small if any effect on subsequent performance in the vague-recognition condition, but had substantial effects on subsequent performance in the accurate-recognition condition. Nevertheless, one tentative result from the words that were repeated in definition and accurate-recognition condition might deserve further study. The number of words that could be defined accurately but not recognized accurately was related to student self-report of having taken SAT preparation vocabulary courses ($\underline{r}$ = .30, $\underline{p}$ < .05), but was not related to the reasoning ($\underline{r}$ = -.04), verbal ($\underline{r}$ = .02) or memory span ($\underline{r}$ = .01) ability composites. This result suggests that such courses encourage students to memorize definitions verbatim rather than establish conceptual networks that enable them to recognize words accurately.

Self-Report Variables

Intercorrelations Among Self-Report Variables

Table 3.3 presents the intercorrelations among the major self-report variables, some of which are summary measures of more detailed variables. The table includes two types of variables--verbal exposure variables and indications of interest in various school subjects. Most of the correlations were small and many were negative, suggesting that there is no general verbal exposure factor and no general "liking-school" factor.

Most of the negative correlations in Table 3.3 might be accounted for by assuming some antagonism between a preference for spatial-analog or holistic processing and a preference for verbal-sequential processing. Most of the variables reflect preference for verbal-sequential processing. The only variables that reflect preference for spatial-holistic processing are television-watching variables, reading comic books, reading magazines, and interest in mechanical and shop courses. The latter variables tended to have negative correlations with the rest of the variables in the table. Note, for instance, that interest in English classes, a variable that reflects preference for verbal-sequential processing, correlated negatively with all the variables that signify preference for spatial-holistic processing. Liking English classes was correlated positively with interest in the other verbal classes (language and social studies classes) but correlated negatively with liking mechanical and shop classes. These correlations and score distributions suggest that students who like English classes tend to like other verbal classes and tend to dislike mechanical and shop classes. These students tend to spend less time watching television or reading comic books, while students who do not like English and other verbal classes tend to spend more time watching television and reading comic books.

Even though the reading-for-pleasure variables correlated substantially with each other, they showed little, if any, relation to reading-for-school variables and the rest of the exposure variables. On the other hand, variables concerned with reading books for school were correlated with spending time on homework, newspaper-reading variables, and liking English and social studies classes. Reading

Table 3.3

Intercorrelations Among Self-Report Variables (N=74)

Self Report Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1.Number of books read for school	-																				
2.Number of books read for pleasure	41	-																			
3.Hours reading books for school	43	10	-																		
4.Hours reading books for pleasure	21	77	11	-																	
5.Number of books listed - school	65	01	31	05	-																
6.Number of books listed - pleasure	23	44	04	59	13	-															
7.Hours spent on homework	39	04	52	01	41	02	-														
8.Hours spent watching television	-13	-12	00	-08	-15	-18	-12	-													
9.Number of television programs listed	-14	-03	-20	-03	-13	-04	-20	61	-												
10.Hours reading newspapers	42	06	32	11	31	05	31	-05	-05	-											
11.Hours reading comic books	-20	-08	03	01	-11	-05	-04	26	44	01	-										
12.Hours reading magazines	-12	-04	49	07	-07	-08	06	14	02	29	39	-									
13.Hours spent writing	20	13	41	26	15	29	26	09	-07	07	-02	17	-								
14.Use of dictionary while reading	-06	-03	-02	10	10	19	28	-02	04	01	47	08	22	-							
15.Like English classes	43	17	01	15	38	27	23	-26	-26	12	-28	-26	19	13	-						
16.Like foreign language classes	14	-02	07	07	20	27	13	-27	-25	18	-21	-04	12	04	38	-					
17.Like social studies	40	25	13	17	31	26	25	-23	-37	17	-41	-09	04	-08	45	14	-				
18.Like science classes	20	-07	10	-03	22	06	13	-15	-22	16	-10	-06	02	02	-02	22	-02	-			
19.Like mathematics classes	02	05	07	04	13	00	27	-15	-32	-06	-18	-11	08	19	-08	17	-18	28	-		
20.Like secretarial or commercial	-05	01	10	09	05	-01	13	14	10	16	-23	-07	14	-22	-06	14	-17	-02	39	-	
21.Like mechanical and shop classes	-11	-22	-08	-14	-02	-08	-04	21	04	-19	-21	[illegible]	-05	-08	-28	-13	-11	22	26	20	-

Note. Decimals omitted. r=.19 significant at .05 level.

comic books related positively with television watching and magazine-reading variables. Factor analysis, cluster analysis, and scaling techniques that were applied to the matrix in Table 3.3 added little to the above interpretation.

Correlations Between Self-Report Variables and Ability Measures

Some possible causal interpretations. There are several possible causal interpretations for a correlation between two variables A and B: A is affecting B, B is affecting A, a third variable C is affecting both A and B, or any combination of the above. The causal interpretation of the correlations between exposure variables and vocabulary measures cannot be restricted to one of these possibilities. The most obvious possibility is that the amount of verbal exposure increases vocabulary knowledge. That is, students who read many books and newspapers have more opportunities to acquire new words than students who read little. Another less obvious interpretation is that verbal ability (which is measured by vocabulary tests) affects the amount of students' verbal exposure. People choose activities that they are good at, since they find them more rewarding. Therefore, students with good verbal-sequential skills are more likely to spend more time reading than students with poor verbal skills. On the other hand, students with poor verbal-sequential skills might find reading frustrating and therefore turn to other more spatial and holistic media such as television and comic books. In other words, the latter interpretation suggests that the effect of verbal ability on amount of verbal exposure is mediated by interests. A model that combines the two interpretations is perhaps the most probable. That is, verbal exposure increases vocabulary knowledge. On the other hand, verbal ability (that is measured by vocabulary tests) affects verbal exposure through its effect on interests.

Some of the results that follow can be best interpreted as exposure affecting ability while others can be best interpreted as ability affecting exposure through its effect on interests.

Holistic vs. sequential processing. Table 3.4 presents the correlations between selected self-report variables and some ability measures. Most of the correlations were small and some were negative.

Table 3.4

Correlations between Selected Self-Report Variables and Ability Measures (N=74)

		Ability Composites						Item Type Scores[b]				Reference Vocabulary Tests			
Self-report variables	Total[a] Score	Verbal	Reasoning	IQ	Spatial	Memory Span	Closure Speed	VR	AR	VD	AD	Advanced Vocab.	WAIS Vocab.	Reading Vocab.	Sex
Number of books read for school	29	26	25	13	05	02	-07	25	24	33	31	31	16	30	-29
Number of books read for pleasure	08	23	08	-05	-20	-02	-05	08	06	13	09	10	07	20	-19
Hours reading books for school	10	00	-04	-02	-06	-17	08	14	08	10	09	07	-04	04	-18
Hours reading books for pleasure	07	00	-07	-14	-26	-06	-14	08	05	11	07	04	08	04	-25
Number of books listed - school	37	34	34	21	11	12	-08	33	35	37	38	41	28	37	-30
Number of books listed - pleasure	23	17	12	11	02	10	03	19	19	25	26	26	20	23	-30
Hours spent on homework	39	27	22	17	-04	13	-15	38	38	39	38	41	20	30	-15
Hours watching T.V.	-37	-37	-28	-26	-16	-40	10	-36	-32	-34	-38	-31	-36	-33	17
Number of T.V. programs listed	-25	-21	-24	-28	-20	-36	15	-23	-21	-21	-27	-20	-20	-16	10
Hours reading newspapers	31	17	21	08	03	10	08	34	29	32	28	34	18	36	05
Hours reading comic books	-11	-09	-09	-25	-23	-25	25	-06	-04	-12	-19	-02	-12	-09	17
Hours reading magazines	08	11	02	00	-03	00	39	13	11	08	02	05	09	16	26
Use of dictionary while reading	23	18	18	09	04	13	09	19	26	20	21	35	13	19	-03
Hours spent writing - (total)	13	05	10	07	04	-11	13	15	07	15	14	19	08	04	-31
Like English classes	44	38	34	25	02	38	-21	35	39	41	49	45	34	34	-34
Like foreign language classes	26	20	31	23	24	15	01	22	23	26	29	26	26	21	-37
Like social studies	27	19	05	09	-10	15	-06	24	22	28	29	26	21	25	03
Like science classes	24	32	32	45	38	00	-01	18	25	26	24	16	26	32	-05
Like mathematics	10	22	43	39	47	19	-01	06	08	14	14	12	13	08	-09
Like secretarial or commercial	-15	-12	02	-02	14	-10	-08	-12	-17	-12	-13	-18	-04	-09	-19
Like mechanical and shop classes	-15	-13	-06	03	23	-18	-06	-13	-19	-15	-14	-23	-10	-12	22

Note. Decimals omitted. r=.19 significant at .05 level.

[a] Total score on the experimental task.

[b] VR, AR, VD, and AD, represent Vague Recognition, Accurate Recognition, Vague Definition, and Accurate Definition.

[c] Sex coded 1=female, 2=male.

Most of the negative correlations in Table 3.4 are correlations between verbal-sequential ability measures and variables reflecting preference for spatial-holistic processing. This suggests that students with poor verbal-sequential skills are the most likely to turn to spatial-holistic media such as television watching and reading comic books. Note, for instance, that the highest negative correlation occurred between television watching variables and performance on memory span tasks. This is an instance of a result that can be best interpreted as ability affecting exposure, as opposed to exposure affecting ability. It seems unlikely that watching television has adverse effects on memory span ability.

While the memory span composite had its highest negative correlation with variables reflecting preference for a spatial processing mode, it had its highest positive correlation with liking English classes. Once again, this suggests that students who have good verbal-sequential skills prefer dealing with verbal materials.

Variables that reflect preferences for spatial-holistic processing had their highest positive correlations with performance on Closure Speed tests, but not with complex spatial analytic tests such as the tests in the spatial ability composite . It is important to distinguish between complex spatial analytic tests and simple holistic tests (see, e.g., Lohman 1979). Reading comic books correlated positively with a Closure Speed factor that was defined by Harshman Figures and Street Gestalt tests ($\underline{r}$ = .25) but was correlated negatively with complex analytic tests such as paper folding ($\underline{r}$ = -.33). Reading magazines had a positive correlations with the Closure Speed factor ($\underline{r}$ = .39) but not with spatial tests. Television watching variables had negative correlations with complex spatial analytic tests but not with the Closure Speed factor.

Vocabulary measures and exposure variables. Correlations in Table 3.4 between vocabulary measures and the exposure variable suggest that students who obtained high scores on vocabulary measures spent more time on their homework, read more books for school, liked English classes, spent more time reading newspapers, and watched less television than students who had low scores on vocabulary measures.

Of the ability measures, vocabulary measures had shown the highest correlations with the verbal-sequential exposure variables. The spatial and the memory span composites were not related to those exposure variables, while the verbal and reasoning composites had similar patterns of correlations with the exposure variables as did the vocabulary measures, even though the correlations were somewhat smaller.

There was some indication that vocabulary tests that require vague recognition of infrequent words (e.g., Advanced Vocabulary Test) measured more individual differences in past verbal exposure and less reasoning than vocabulary tests that required accurate definition of mostly easy and medium difficulty words (e.g., WAIS Vocabulary). Of all the ability measures, Advanced Vocabulary had the highest correlations with many of the exposure variables such as: use of dictionary while reading, reading newspapers, time spent on homework, and number of books read for school and for pleasure (as indicated by number of books listed). Note that advanced vocabulary had higher correlations with these exposure variables than the WAIS Vocabulary, even though the WAIS Vocabulary correlated higher with the reasoning composite. Of all the vocabulary measures, advanced vocabulary had one of the lowest correlations with the reasoning composite (see Table 3.2).

Ability measures and interests. The correlations of the "likes" with ability composites suggest that students like classes that they are good at, probably since they find these activities more rewarding. The correlations in Table 3.4 and the respective distributions suggest that students who like classes are students who have highly developed verbal-sequential skills. These students had high scores on the memory span composite, the verbal ability composite and the vocabulary measures.

Students who like mathematics and science classes had high scores on the reasoning and the spatial ability composites. Of all the ability measures, the quantitative achievement composite had the highest correlation with liking mathematics classes ($r = .51$).

Students who like social studies tended to have better verbal than spatial skills. On the other hand, students who liked mechanical and shop classes tended to have better spatial than verbal skills. The verbal vs. spatial difference score (verbal composite minus spatial composite) correlated .37 with liking social studies classes, and -.32 with liking mechanical and shop classes.

The results also suggest that girls like more English and foreign language classes than boys, and that boys like more mechanical and shop classes. Girls reported reading more books and spending more time writing (the correlation is mainly due to writing letters) than boys, while boys reported reading more magazines than girls. There were no sex differences in the study sample on the ability measures. Therefore, the differential correlations of abilities with self-report variables can not be attributed to the sex variable.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The major purpose of this study was to investigate trait and process aspects of vocabulary knowledge and verbal ability that might lead to better understanding of the construct validity of vocabulary tests and the nature of verbal ability. Verbal ability is psychometrically defined by complex verbal tests that measure language comprehension and word knowledge. The verbal ability or verbal comprehension factor closely approximates Horn and Cattell's (1966) crystallized intelligence, or Gc factor, and is most often defined by vocabulary tests. It was suggested that verbal ability is facility in creating and operating on semantic networks--in particular it is facility in acquiring word or concept meanings from their contexts (e.g., sentences or paragraphs), and understanding contexts from concepts embedded in them. The former aspect of verbal ability is measured by vocabulary tests, and most directly by reading vocabulary tests that demand understanding of how a word is used in context. The latter aspect is measured most directly by reading comprehension tests.

It was suggested that vocabulary tests show strong relations with general intelligence and reasoning abilities because they reflect the ability to infer the meanings of words from their contexts. Most complex verbal tests measure current knowledge built up from prior investments of ability in education and verbal experience. Vocabulary tests, then, measure current knowledge (number of words the person has learned) resulting from facility in word acquisition as well as extent of verbal exposure. Such tests appear deceptively simple, since the complex reasoning processes involved in past word acquisition are not obviously involved in present performance.

This study included three kinds of measurements: an experimental faceted vocabulary test, reference ability tests, and a verbal exposure questionnaire. The faceted vocabulary test was used to study sources of difficulty in vocabulary test performance and how these sources of difficulty affect the relations between vocabulary tests and other ability measures. Inferences about what is measured by the various vocabulary aspects were made by examining the differential correlation of the vocabulary aspects (levels of a facet) with ability measures and verbal exposure variables. Inferences about the information-processing difficulties associated with being low on various abilities were made by examining the differential effect of source of difficulty represented by the facets on low- and high-ability students.

Method

The experimental task was a 3x3x3x2 faceted vocabulary test with five items per cell. The facets of this test were word abstractness (concrete, medium, abstract), word frequency (low, medium, high), item type (vague recognition, accurate recognition, definition), and blocks (two parallel blocks). The item-type facet included two contrasts: a production contrast to compare definition vs. recognition items, and an accuracy contrast to compare vague vs. accurate-recognition items. The reference battery included tests that define general mental ability, verbal ability, spatial ability, memory span, and closure speed. The verbal exposure questionnaire assessed frequency and time spent in reading (books, newspapers, and magazines), writing, doing homework, and viewihg television. Subjects were 74 Palo Alto high school seniors selected to represent the bivariate distribution of verbal and spatial ability in a reference population of high school seniors.

Results and Discussion

Means Analysis

The results of the means analysis indicated that the difficulty of vocabulary items was affected by word characteristics as well as by aspects of item format. Vocabulary item difficulty increased with word abstractness and word infrequency. Abstract words were more difficult than concrete words and infrequent words were more difficult than frequent words. Vocabulary item difficulty increased also when item format required more precise word knowledge, and when the item required definition as opposed to recognition of the word. Accurate-recognition items that demanded precise knowledge of word meaning were more difficult than vague-recognition items similar to items that appear on many multiple choice vocabulary tests. The results implied that the difficulty of abstract words was not due to difficulty in defining them but rather to difficulty in acquiring their meanings.

Word Acquisition as a Stochastic Process

It was suggested that the process of word acquisition can be viewed as a stochastic process in which words are continuously moving from an unlearned state through one or more partial knowledge states into a learned state as a function of repeated exposure to the words in contexts (e.g., sentences). Administering a vocabulary test can be thought of as taking a picture of the acquisition process at a certain point in time. The experimental design allowed examination of the distribution of words in various knowledge states at the point in time and individual differences in this distribution among students that reflected their abilities. Low-ability students were seen to have more words in partial knowledge states than high-ability students. The results suggested that partial concepts are prevalent in young adults and that word acquisition is a gradual process. Many words could be recognized vaguely but not accurately, or defined vaguely but not accurately, or recognized but not defined. Words that were defined correctly were also recognized correctly. The conditional probability of correctly recognizing a word once it was defined correctly was .96.

Reasoning Ability and Vocabulary Knowledge

The sources of difficulty in vocabulary test performance were found to affect not only the difficulty of vocabulary measures but also to affect their relations with reasoning, spatial, and memory span tests. These correlations suggested the kinds of roles reasoning, spatial-analog, and sequential processes play in the acquisition and definition of words.

The following lines of evidence hinted at the role of reasoning or higher-order control processes in the acquisition or definition of words:

1. When trying to define a word, subjects reported attempting to retrieve different propositions in which the word previously

appeared. Some responses indicated that subjects could give correct examples of how the word was used in sentences but inferred incorrect defining features.

2. Other results suggested that students with low reasoning ability had major difficulties in the inference process during the definition stage. Some words appeared only once in the design, while others appeared in the definition condition and then in one of the recognition conditions. Performance of students with high reasoning ability was improved in the accurate-recognition condition when this condition followed the definition condition (i.e., as a result of defining the word first); the performance of students with low reasoning ability became worse when definition preceded recognition. This implies that highs may have made mostly correct inferences during the definition stage that were helpful during subsequent performance in the recognition condition. On the other hand, lows may have made more wrong inferences during the definition stage that interfered with subsequent performance in the recognition condition.

3. Other evidence indicated that the reasoning composite related to vocabulary measures at the lower end of the vocabulary distribution but not at the higher end. This suggests that a certain level of reasoning ability is necessary for effective extraction of word meaning. Above this level, reasoning ability makes little difference in performance on vocabulary tests; presumably other skills that are specific to verbal ability and vocabulary knowledge take precedence.

4. Vocabulary items that required the student to do more than merely recognize the correct meaning of a word had higher correlations with reasoning than recognition vocabulary items. For example, definition items and a reading vocabulary test had relatively high relations with reasoning. On the other hand, vague-recognition measures had the lowest relations with reasoning, presumably because they measure few output processes and so a substantial portion of their variance depends on past exposure and retention. Consistent with this interpretation were some indications that vocabulary tests that required vague recognition of infrequent words reflect more past exposure variance than other vocabulary and verbal ability measures.

Memory Span, Spatial Ability and Vocabulary Knowledge

Various lines of evidence hinted at the role of verbal-sequential and spatial-analog processes in the acquisition or definition of words. The results suggested that spatial-analog processes are involved in the acquisition or definition of concrete words but not in the acquisition or definition of abstract words, where students seemed to rely entirely on sequential processes. Concrete word items had significantly higher correlations with spatial ability than did abstract word items. On the other hand, abstract word items had significantly higher correlations with memory span than did concrete word items. Students with low sequential skills as measured by memory span tests appeared to have major difficulties in solving abstract word items. Similarly, students reported retrieving prototype images of words while solving concrete word items but not while solving abstract word items.

These and other results suggest that spatial ability measures may relate to vocabulary tests for two reasons. First, both vocabulary tests and complex spatial tests require reasoning. Second, spatial-analog processes are involved in the acquisition and retrieval of concrete words. Abstract word items appeared to relate to spatial ability primarily because complex spatial tests measure reasoning. However, concrete word items related to spatial ability even when reasoning was statistically controlled, probably because spatial-analog processes are involved in the acquisition and definition of concrete words.

Other results suggested that there was some antagonism between preferences for holistic processing vs. preference for and skills in sequential processing. Most of the negative correlations among self-report variables, and between self-report variables and ability measures could be accounted for by this antagonism.

Word Difficulty and Verbal Ability

Other results imply that verbal ability as represented by reading comprehension and reading vocabulary tests is best measured by frequent or medium-frequency words rather than by rare words. On the other hand, difficult recognition vocabulary tests such as advanced vocabulary tests seem to measure mainly sources of difficulty due to infrequent words—sources that are not central to verbal ability, and that are related to individual differences in verbal exposure. Frequent words are words to which everyone has been exposed; failing to comprehend them must result mainly from failure to extract accurate meanings during the acquisition or definition stages rather than from lack of exposure. Thus, frequent and medium-frequency words provide better measures of verbal ability than do rare words, because they reflect more of the ability to extract word meaning from context, and less of variation in exposure.

Exposure Variables, Interests and Vocabulary Knowledge

Other results hint at the role of exposure and interest variables in the acquisition of vocabulary and other verbal knowledge. It was suggested that causal interpretation of the correlations between exposure variables and ability measures cannot be restricted to one possibility. The most obvious possibility is that the amount of verbal exposure increases vocabulary knowledge. That is, students who read many books and newspapers have more opportunity to acquire new words than students who read little. Another less obvious interpretation is that verbal ability as measured by vocabulary tests, affects the amount of students' verbal exposure through its effect on interests.

Most of the correlations between ability measures and exposure variables were small. Those correlations suggested that students who obtained high scores on vocabulary and other verbal tests spent more time on their homework, read more books for school, liked English classes, spent more time reading newspapers, and watched less television than students who had low scores on verbal tests.

Of the ability measures, vocabulary had the highest correlations with verbal-sequential exposure variables. The spatial and memory span composites were not related to those exposure variables. The verbal and reasoning tests had patterns of correlations with exposure variables that were similar to the patterns for the vocabulary measures even though the correlations were somewhat smaller.

The results also suggested that students with poor verbal-sequential skills as measured by memory span were the most likely to turn to spatial holistic media such as television watching and reading comic books. On the other hand, students with good verbal-sequential skills showed preferences for verbal materials.

In general, these results are consistent with the view that most verbal tests measure current knowledge that reflects crystallization of aptitude and verbal experience. They are also consistent with the suggestion that it is the ability to infer the meaning of words from their contexts which vocabulary tests measure that is responsible for their strong relations with reasoning abilities and general intelligence. The results suggest that while verbal tests measure an ability to deal with verbal-sequential information, performance on certain aspects of verbal tasks can benefit from the use of spatial-analog strategies and use of spatial skills. The results also suggest that students with poor verbal-sequential skills had particular difficulties with abstract words. Students with relatively little verbal exposure had particular difficulties with rare words, students with poor reasoning skills had major difficulties with definition items, and students with high spatial ability had an advantage in the acquisition or definition of concrete words.

Further studies that concentrate directly on the learning processes and skills involved in the acquisition of words are needed to test and elaborate the interpretations suggested here.

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APPENDIX A

THE VERBAL EXPOSURE QUESTIONNAIRE

NAME ____

Verbal Exposure Questionnaire

1. List as best you can the titles of all the books you can remember reading during the past month. If you read part of a book (over 50 pages), list that also and put a star next to the title:

   a. Assigned in school:

   b. For pleasure:

2. About how many books (other than mathematics, physics, chemistry, comic or picture books) do you read per month? (Circle theappropriate number.)

a. Assigned in school:	b. For pleasure:
None	None
Part of one	Part of one
One	One
Two	Two
Three	Three
Four	Four
Five	Five
More than five (Specify how many.___)	More than five(Specifyhow many___)

3. About how many hours per week do you spend reading books?

   a. Assigned in school ___

   b. For pleasure ___

4. Which magazines do you read regularly? Please list below any magazine you read regularly (for example, Sports Illustrated, Time, National Geographic, True Confessions, Stereo Review):

5. About how many hours per week do you spend reading magazines? ____

6. About how many hours per week do you spend reading comic books? ____

7. Which newspapers do you read regularly? Please list them below:

8. About how many hours per week do you spend reading newspapers? ____

9. What newspaper sections do you read regularly? Please check all the sections that you read regularly:

___a. News
___b. Comics
___c. Business, Markets
___d. Editorials, Columns
___e. Sports
___f. T.V., Radio, Movies, Weather

10. Please list below all the T.V. programs you watch regularly:

11. About how many hours per week do you spend watching T.V.? ____

About how many hours per week do you spend watching on T.V. each of the following:

a. News, interviews, discussions ____

b. Plays and movies ____

c. Educational programs (such as Nova) ____

d. Daily and weekly serials (such as Edge of Night, Mash) ____

e. Sports, game shows (such as Hollywood Squares), cartoons ____

f. Other (Please indicate which other.) __________

12. About how many hours per week do you spend writing? _____

About how many hours per week do you spend writing for each of the following:

a. School assignments	b. Pleasure
Term papers, essays ____	Term papers, essays ____
Short stories ____	Short stories ____
Poetry ____	Poetry ____
Journal or diary ____	Journal or diary ____
Letters ____	Letters ____
Other ____(Specify) _________	Other ____(Specify) _______

13. Approximately how many times a week do you use a dictionary: when reading ____? when writing ____? (Choose the appropriate letter from the following list.)

a. Less than once per week

b. Once or twice

c. Three to five times

d. About six times

e. More than ten times.

14. About how many hours per week do you spend on homework? ____

15. About how many movies do you go to per month? ____

16. About how many hours per week do you play word games (for instance, Scrabble, Cross-word puzzles)?

17. Has the amount of your reading changed since junior high school? (Please check all the appropriate categories):

a. Books	b. Magazines	c. Newspapers
___About the same	___About the same	___About the same
___I read more now	___I read more now	___I read more now
___I read less now	___I read less now	___I read less now

18. Have you studied vocabulary words? (Please check all the appropriate answers below):

___a. To prepare for college entrance tests

___b. In school courses

___c. On your own

19. Circle the number on the scale from 1 to 7 that indicates how much you like or dislike the following subjects:

	dislike very much			neither like nor dislike			like very much
a. English	1	2	3	4	5	6	7
b. Foreign languages	1	2	3	4	5	6	7
c. Social studies	1	2	3	4	5	6	7
d. Science	1	2	3	4	5	6	7
e. Math	1	2	3	4	5	6	7
f. Secretarial or commercial courses	1	2	3	4	5	6	7
g. Mechanical and shop courses	1	2	3	4	5	6	7

APPENDIX B

INSTRUCTIONS TO RATERS OF WORD ABSTRACTNESS

Instructions to Raters of Word Abstractness

Words may refer to persons, places and things that can be seen, heard, felt, smelled, or tasted or to bastract concepts that cannot be experienced by our senses. The purpose is to rate the words with respect to "concreteness" in terms of sense experience. Any word that refers to objects, materials, persons should receive a high concreteness rating. Any word that refers to abstract concepts, which cannot be experienced by the senses should receive a low concreteness rating. Think of the words "chair" and "independence." "Chair" can be experienced by our senses and therefore should be rated as high concrete; "independence" cannot be experienced by the senses and therefore should be rated as low concrete (abstract).

Rating System:

First, look through the words to get a general idea of how they range with regard to "concreteness." Then, to the left of every word, put an H if you consider it to be High Concrete, M if you consider it to be Medium Concrete, and L if you consider it to be abstract. After this process is finished, put a star next to the High Concrete words which you consider to be especially concrete within the High category, and next to the abstract words which you consider to be especially abstract within the Low category.

APPENDIX C

ITEMS IN THE EXPERIMENTAL TASK:

1. DEFINITION ITEMS (TWO BLOCKS)
2. VAGUE RECOGNITION ITEMS (TWO BLOCKS)
3. ACCURATE RECOGNITION ITEMS (TWO BLOCKS)

1. DEFINITION ITEMS (TWO BLOCKS)

Name ____

WORD MEANINGS (Part I)

Instructions

This is a test of your knowledge of word meanings. On the next page there is a list of words. Your task is to write out the meanings. Use a synonym if you can, but also explain each word even if you can give a synonym. For example:

1. breakfast	The first meal of the day.
2. conceal	Hide. Keep from view.
3. enormous	Huge. Exceeding the usual size.

Do the words you know first; then go back and do the words you are not sure of.

1.dusk		
2.stroll		
3.gale		
4.pebble		
5.dome		
6.mar		
7.decree		
8.retort		
9.reap		
10.sullen		
11.exert		
12.renown		
13.impart		
14.implore		
15.perpetual		
16.debris		
17.dregs		
18.anvil		
19.abyss		
20.fang		
21.banter		
22.colossal		
23.meek		
24.dejected		
25.malady		
26.avarice		
27.candor		
28.beguile		
29.appease		
30.plausible		
31.caldron		
32.agate		
33.cartilage		
34.geyser		
35.aqueduct		
36.meticulous		
37.affluent		
38.throes		
39.acme		
40.diffident		
41.poignant		
42.amorphous		
43.lucrative		
44.adroit		
45.mitigate		

Name ______________________________

WORD MEANINGS (Part 2)

Instructions

This is a test of your knowledge of word meanings. On the next page there is a list of words. Your task is to write out the meanings. Use a synonym if you can, but also explain each word even if you can give a synonym. For example:

1. breakfast	The first meal of the day.
2. conceal	Hide. Keep from view.
3. enormous	Huge. Exceeding the usual size.

Do the words you know first; then go back and do the words you are not sure of.

1.fugitive		
2.granite		
3.serpent		
4.plateau		
5. cot		
6.banish		
7.narrative		
8.vicinity		
9.dreary		
10.peril		
11.petty		
12.blunder		
13.plight		
14.prevail		
15.exclusively		
16.contour		
17.portal		
18.venison		
19.crevice		
20.capillary		
21.immerse		
22.cringe		
23.curtail		
24.wrangle		
25.buoyant		
26.intricate		
27.heedless		
28.entail		
29.dauntless		
30.essence		
31.bauble		
32.custodian		
33.toga		
34.cyst		
35.bison		
36.dank		
37.slovenly		
38.toxic		
39.pittance		
40.strata		
41.sporadic		
42.inundate		
43.digress		
44.clemency		
45.laudable		

2. VAGUE RECOGNITION ITEMS (TWO BLOCKS)

Name ____

VOCABULARY (Part 1)

Instructions

This is a test of your knowledge of word meanings. Look at the sample below. One of the four numbered words has the same meaning or nearly the same meaning as the word above the numbered words. Mark your answer by putting an X through the number in front of the word that you select as closest in meaning to the word.

happy
1.refreshing
2.scare
3.wise
4.jolly

The answer to the sample item is number 4; therefore, an X has been put through number 4.

Your score will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong. However, if you do decide to guess on any of the items, place a question mark to the left of that item.

1.apparel
  1.fear
  2.clothing
  3.fine food
  4.dishware

2.apprentice
  1.trainee
  2.teacher
  3.horse trader
  4.jockey

3.banquet
  1.small bank
  2.a British sport
  3.hot coals
  4.elaborate feast

4.sash
  1.cloth ribbon
  2.break-up
  3.collar
  4.laugh loudly

5.coral
  1.pasture for horses
  2.body of water
  3.heavenly
  4.deep pink

6.fragrant
  1.worn-out
  2.sweet-smelling
  3.easily broken
  4.rosy

7.revenue
  1.value
  2.service
  3.goods
  4.income

8.daze
  1.please
  2.wish
  3.shock
  4.stare

9.timid
  1.self-assured
  2.weak
  3.shy
  4.tender

10.commend
  1.praise
  2.order
  3.demote
  4.possess

11.accommodate
  1.be punctual
  2.ask for help
  3.relax
  4.adapt

12.desolate
  1.hungry
  2.deserted
  3.without light
  4.safe

13.cope
  1.ask
  2.help
  3.sleep soundly
  4.manage

14.contemplate
  1.impress
  2.withold
  3.consider
  4.remember

15.mellow
  1.ripe
  2.salty
  3.silent
  4.fruitful

16.alumni
  1.classes
  2.graduates
  3.friends
  4.marching band

17.beacon
  1.light
  2.clerical title
  3.crown
  4.credit

18.urn
  1.wallet
  2.stage play
  3.poem
  4.container

19.fossil
  1.accurate definition
  2.window shelf
  3.hardened remainder
  4.cotton fabric

20.flask
  1.bottle
  2.fasten
  3.slap
  4.cloak

21. havoc
  1.camp
  2.swing
  3.prosperity
  4.disorder

22.immaculate
  1.mysterious
  2.rare
  3.spotlessly clean
  4.very elegant

23.lavish
  1.earnest
  2.affectionate
  3.polished
  4.abundant

24.obsolete
  1.concrete
  2.imperfect
  3.fat
  4.outdated

25.anecdote
  1.medication
  2.story
  3.concern
  4.poem

26.transient
  1.passing
  2.ancient
  3.ambitious
  4.exciting

27.contaminate
  1.light up
  2.make impure
  3.drive
  4.continue

28.perennial
  1.fatherly
  2.grand
  3.regular
  4.mature

29. evolve
  1.return
  2.open
  3.develop
  4.spin

30.aversion
  1.drowning
  2.dislike
  3.volume
  4.concern

31. amphibian
    1. fierce beast
    2. medical technician
    3. cold-blooded animal
    4. ancient priest

32. abscess
    1. sore
    2. vacation
    3. medal
    4. bill

33. crockery
    1. broken glass
    2. deception
    3. pottery
    4. flattery

34. vial
    1. avenue
    2. suitcase
    3. detail
    4. jar

35. algae
    1. carpenter's tool
    2. water bird
    3. weapon
    4. aquatic plant

36. procrastinate
    1. speak harshly
    2. chime
    3. delay
    4. celebrate

37. succulent
    1. angry
    2. juicy
    3. sour
    4. talkative

38. delectable
    1. delicious
    2. unimportant
    3. theoretical
    4. terrible

39. flippant
    1. sloppy
    2. amazing
    3. ridiculing
    4. tilted

40. divulge
    1. reveal
    2. spread
    3. jump
    4. steal

41. coy
    1. simple
    2. neat
    3. playful
    4. careful

42. gratuitous
    1. free
    2. grateful
    3. scholarly
    4. cheerful

43. obviate
    1. explain
    2. emphasize
    3. pretend
    4. prevent

44. enigma
    1. opponent
    2. formula
    3. story
    4. mystery

45. adulation
    1. accusation
    2. admiration
    3. imitation
    4. grief

Name ____

VOCABULARY (Part 2)

Instructions

This is a test of your knowledge of word meanings. Look at the sample below. One of the four numbered words has the same meaning or nearly the same meaning as the word above the numbered words. Mark your answer by putting an X through the number in front of the word that you select as closest in meaning to the word.

happy
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1. fugitive
   1. laborer
   2. escapee
   3. hero
   4. boxer

2. granite
   1. textured
   2. dark
   3. hard rock
   4. made of wheat

3. serpent
   1. tax
   2. snake
   3. surgeon
   4. player

4. plateau
   1. raised plain
   2. farm land
   3. French sausage
   4. mountain stream

5. cot
   1. children's song
   2. small bed
   3. fluid measure
   4. fruit

6. banish
   1. disappear
   2. exile
   3. spoil
   4. change

7. narrative
   1. origin
   2. story
   3. song
   4. pathway

8. vicinity
   1. strong dislike
   2. vitality
   3. neighborhood
   4. sacred ceremony

9. dreary
   1. gloomy
   2. slow
   3. noisey
   4. frightening

10. peril
    1. precious metal
    2. tiny
    3. sea animal
    4. danger

11. petty
    1. affectionate
    2. unimportant
    3. easily influenced
    4. cute

12. blunder
    1. musical instrument
    2. weapon
    3. mistake
    4. kitchen appliance

13. plight
    1. hardship
    2. plague
    3. good behavior
    4. departure

14. prevail
    1. persist
    2. cover up
    3. plan beforehand
    4. predict

15. exclusively
    1. totally
    2. rarely
    3. expensively
    4. solely

16. contour
    1. hair style
    2. area
    3. detour
    4. outline

17. portal
    1. column
    2. entrance
    3. curtain
    4. ancient

18. venison
    1. inhabitant
    2. man from Venice
    3. deer meat
    4. salt water fish

19. crevice
    1. bad habit
    2. crack
    3. burden
    4. ailment

20. capillary
    1. blood vessel
    2. young butterfly
    3. military rank
    4. cafeteria

21. immerse
    1. plunge
    2. hide
    3. retard
    4. increase

22. cringe
    1. destroy
    2. grab onto
    3. paint
    4. shrink back

23. curtail
    1. window covering
    2. shorten
    3. end of a play
    4. frighten

24. wrangle
    1. rustle
    2. tremble
    3. quarrel
    4. fasten

25. buoyant
    1. showy
    2. healthy
    3. light
    4. silly

26. intricate
    1. capable
    2. complex
    3. fragile
    4. delicious

27. heedless
    1. peerless
    2. fruitless
    3. meaningless
    4. thoughtless

28. entail
    1. involve
    2. trace
    3. manage
    4. appeal

29. dauntless
    1. shameless
    2. with no equal
    3. flawless
    4. without fear

30. essence
    1. smell
    2. basis
    3. tension
    4. agreement

31.bauble
1.confuse
2.ornament
3.tool
4.drop

32.custodian
1.caretaker
2.owner
3.tradition
4.aggressor

33.toga
1.Greek weapon
2.Indian headdress
3.Roman garment
4.Egyptian soldier

34.cyst
1.swelling
2.gem
3.dwelling
4.male swan

35.bison
1.pilot
2.antelope
3.slave
4.buffalo

36.dank
1.moist
2.slim
3.heavy
4.weak

37.slovenly
1.foreign
2.serious
3.untidy
4.festive

38.toxic
1.poisonous
2.diseased
3.small
4.disagreeable

39.pittance
1.fuel
2.exit
3.deep hole
4.small amount

40.strata
1.brace
2.rocks
3.layers
4.clouds

41.sporadic
1.moldy
2.energetic
3.occasional
4.false

42.inundate
1.overflow
2.convert
3.trap
4.shout

43.digress
1.deviate
2.plow
3.eat
4.devote

44.clemency
1.weakness
2.occupancy
3.mercy
4.restraint

45.laudable
1.out loud
2.able to see
3.in debt
4.praiseworthy

3. ACCURATE RECOGNITION ITEMS (TWO BLOCKS)

Name ______________________________

WORD KNOWLEDGE (Part 1)

Instructions

This is a test of your knowledge of word meanings. Look at the sample below. One of the four numbered phrases has the same meaning or nearly the same meaning as the word above the numbered phrases. Mark your answer by putting an X through the number in front of the phrase that you select as the closest in meaning to the word.

beware
  X.to be on guard
  2.to be weary
  3.to be frightened
  4.to be unsure of oneself

The answer to the sample item is number 1; therefore, an X has been put through number 1.

Your score will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong. However, if you do decide to guess on any of the items, place a question mark to the left of that item.

1.plume
1.hat decorated with a feather
2.feather worn as an ornament
3.pen made out of a feather
4.bird having elaborate feathers

2.gap
1.crack in a piece of glass
2.pit in a field or lawn
3.endless space
4.break in a wall or hedge

3.barrier
1.object which is in one's way
2.problem that is hard to solve
3.fence which easy to pass
4.difficult road to drive

4.obscure
1.not easy to lift or pull
2.completely without light
3.invisible to the naked eye
4.not easily seen or understood

5.pillar
1.column which supports a structure
2.fence that outlines a land claim
3.tall straight tree
4.tall wall that protects a city

6.prey
1.helpless victim
2.small animal
3.helpless child
4.frightened being

7.feat
1.difficult problem
2.long journey
3.deed of courage
4.act of compassion

8.lurk
1.delay a start
2.hide valuables
3.wait for darkness
4.wait in hiding

9.crave
1.have a strong intuition
2.struggle to create
3.struggle to succeed
4.have a strong desire

10.lure
1.catch unexpectedly
2.purposefully attract
3.innocently charm
4.flatter excessively

11.frantic
1.moving with quick energy
2.marked by fast nervous activity
3.marked by graceful movements
4.moving with swift efficient steps

12.divert
1.turn from one course to another
2.entertain or amuse with conversation
3.catch a person's attention
4.deceive by joking or flattery

13.indispensable
1.useful for survival
2.absolutely necessary
3.needed for completion
4.economically necessary

14.adequate
1.can be made to suffice
2.sufficient for a requirement
3.more than is wanted
4.necessary for survival

15.instinct
1.a well learned habit
2.a tendency to imitate others
3.a need for social interaction
4.a natural tendency

16.cascade
1.steep fall of water
2.volcanic eruption
3.fountain with multi-colored lights
4.jet of steam

17.cataract
1.infection of the eyelid
2.injury to the nerve endings of the eye
3.clouding of the lens of the eye
4.weakness of the eye muscles

18.citadel
1.fortress that guards a city
2.building where weapons are kept
3.strong high wall
4.strong fence to prevent escape

19.cherub
1.a chirping bird
2.a chubby rosy child
3.a healthy cheerful young girl
4.a curly-headed child

20.goblet
1.drinking vessel with a foot and stem
2.container made of heavy glass
3.small bottle
4.container for carrying water

21.embark
1.to continue one's effort
2.to make a start
3.to start to fall
4.to end a conversation

22.ardor
1.extreme interest
2.great pain
3.great passion
4.extreme compassion

23.invert
1.to reverse in position
2.to change one's clothes
3.to return
4.to change one's mind

24.harrass
1.to make noise
2.to bump into intentionally
3.to annoy persistently
4.to hurt someone unintentionally

25.bide
1.to leave behind
2.to wait awhile
3.to lengthen
4.to keep back

26.wary
1.extreme fear of pain
2.marked by keen caution
3.reserved in one's behavior
4.closely observing of others

27.deduce
1.generalize from a set of examples
2.divide into sub-parts or sections
3.build a new theory or model
4.infer from a general principle

28.dispel
1.drive away by scattering
2.send out on an errand
3.discharge for poor conduct
4.send away with regret and sadness

29.preposterous
1.having a slight possibility of occurring
2.true but not believed
3.known only by a few people
4.contrary to nature or reason

30.sublime
1.above any possible criticism
2.elevated in dignity or honor
3.knighted to a royal position
4.prized for great intellectual works

31.convex
1.arched like a circle
2.rectangular in shape
3.having a rough outline
4.shaped like an hour-glass

32.dowry
1.certificate of marriage
2.marriage oath taken by the bride
3.marriage oath taken by the groom
4.gift from a bride to her husband

33.carnage
1.select portions of beef
2.left-overs from a meal
3.bloody slaughter
4.ruins from a building

34.quintet
1.group of five
2.one-fifth of a whole
3.five repetitions
4.five-sided figure

35.gondola
1.boat used in the canals of Amsterdam
2.small sail boat
3.boat used in the canals of Venice
4.small boat accompanying a ship

36.nadir
1.the lowest point
2.the highest point
3.the point furthest to the right
4.the point furthest to the left

37.agrarian
1.related to weather
2.related to production
3.related to fields or land
4.related to water or the sea

38.bevy
1.a group
2.a set
3.a pair
4.a few

39.bedlam
1.a scene of confusion
2.an organized mass of people
3.a complex activity
4.a loud roar

40.altercation
1.a quiet disagreement
2.a noisy angry fight
3.an organized fight
4.a court decision

41.ablution
  1.the cleansing of one's spirit
  2.the washing of one's body
  3.a flooding by rain
  4.a purification by fire

42.levity
  1.extreme joy or happiness
  2.extreme anxiety
  3.excessive heaviness of mood
  4.excessive lack of seriousness

43.allegory
  1.expression using symbolic representation
  2.story based on realistic events
  3.fable telling of great deeds
  4.ballad telling of an ancient hero's life

44.equitable
  1.being profitable
  2.receiving equal amounts from all
  3.dealing fairly
  4.operating at a loss

45.volition
  1.act of making a decision
  2.act of being creative and productive
  3.act of taking a chance
  4.act of being helpful

Name ______________________________________

WORD KNOWLEDGE (Part 2)

Instructions

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1. dusk
   1. the shadow caused by a large object
   2. the dark just before sunrise
   3. the darkness caused by a storm
   4. the darker part of twilight

2. stroll
   1. to walk with small steps
   2. to walk in a leisurely manner
   3. to walk with hesitation
   4. to walk while conversing with another

3. gale
   1. a very strong wind
   2. a heavy burst of rain
   3. a storm with lightening and thunder
   4. a flood caused by rain

4. pebble
   1. a small sharp object
   2. a small round jewel
   3. a small sea shell
   4. a small rounded stone

5. dome
   1. a roof made of curved tiles
   2. a ceiling made of patterned tiles
   3. a large semi-circular roof or ceiling
   4. the round ceiling of a circular building

6. mar
   1. to completely destroy
   2. to detract attention from
   3. to detract from the perfection of
   4. to injure or infect

7. decree
   1. a judicial decision
   2. a formal complaint
   3. a legal document
   4. a judicial appeal

8. retort
   1. a biting reply
   2. a short answer
   3. a short insulting statement
   4. a quick witty remark

9. reap
   1. to store a harvest
   2. to seed a field
   3. to pick flowers
   4. to gather a crop

10. sullen
    1. primly reserved
    2. resentfully silent
    3. quietly watchful
    4. calmly accepting

11. exert
    1. to exercise steadily
    2. to last a long time
    3. to use great effort
    4. to move at a fast pace

12. renown
    1. the state of having a bad reputation
    2. the state of being highly honored
    3. the state of being in great conflict
    4. the state of being controversial

13. impart
    1. to tell an elaborate story
    2. to gossip habitually
    3. to pursue by intense pressure
    4. to communicate the knowledge of

14. implore
    1. to convince with arguements
    2. to attack with angry words
    3. to beg or pray earnestly
    4. to insult with mockery

15. perpetual
    1. occurring continually or forever
    2. occurring in short even intervals
    3. moving in long smooth strides
    4. moving in circular paths

16. debris
    1. remains of something destroyed
    2. left-over food or drink
    3. cracked glass
    4. tangled mass of fiber or hair

17. dregs
    1. material that rises to the surface of a solution
    2. the most undesired parts
    3. the hind part of an animal
    4. an unfinished job

18. anvil
    1. a hammer for shoeing horses
    2. an instrument for cutting metal
    3. a mold for shaping metal
    4. a block for shaping metal

19. abyss
    1. a long cave or passageway
    2. a vast expanse of space
    3. an immeasurably deep pit
    4. a very broad plane or field

20. fang
    1. a long sharp tooth
    2. a long sharp weapon
    3. a broad rough-edged tooth used for chewing
    4. a sharp thin dentist's instrument

21.banter
1.practical joking
2.good-natured laughter
3.good-natured joking
4.warm-hearted greeting

22.colossal
1.something very fast
2.something very hard and unbending
3.something frightening
4.something huge or powerful

23.meek
1.mild and submissive
2.pale and tired
3.thin and undernourished
4.weak and unhealthy

24.dejected
1.knocked down
2.down in spirits
3.put down by an insult
4.defeated

25.malady
1.an uncertain future
2.a large epidemic
3.a strange feeling
4.an unhealthy condition

26.avarice
1.hiding of valued objects
2.excessive desire for wealth
3.theft of treasure
4.excessive collecting of objects

27.candor
1.superficial appearance of honesty
2.unreserved honesty and sincerity
3.innocently made mistakes
4.pure and unused by others

28.beguile
1.to convince by discussion
2.to charm by the use of magic
3.to deceive by the clever use of lies
4.to persuade by the use of charm

29.appease
1.to sooth the pain of a wound
2.to bring to a state of peacefulness
3.to quiet with a lullaby
4.to bring an end to disagreement by compromise

30.plausible
1.appearing worthy of belief
2.proven beyond any doubt
3.suspicious without valid cause
4.true without requiring proof

31.caldron
1.a large water cooler
2.a large machine for manufacturing steam
3.a large kettle or boiler
4.a large structure for storing gravel

32.agate
1.a hard green stone
2.a fine-grained striped stone
3.a multi-colored transparent stone
4.a valuable sparkling stone

33.cartilage
1.the primary unit of the nervous system
2.the hollow parts of bone
3.the muscles for fine control
4.the elastic tissue of the skeleton

34.geyser
1.a spring jetting water and steam
2.an erupting volcano
3.a natural stream for warm water
4.a three-layered water fall

35.aqueduct
1.a structure for storing water
2.a structure for the passage of water
3.a machine for lifting water
4.a structure for blocking water

36.meticulous
1.marked by extreme interest in art
2.marked by extreme concern for others
3.marked by extreme need
4.marked by extreme concern for detail

37.affluent
1.having a sufficient supply
2.having an abundant supply
3.having a plentiful harvest
4.having a rich relative

38.throes
1.a harsh pain or struggle
2.an act of violence
3.a strong or intense emotion
4.a bloody battle

39.acme
1.an accurate representation
2.the best reproduction
3.the highest point or stage
4.an enlarged copy

40.diffident
1.slow due to fatigue
2.careful due to lack of knowledge
3.hesitant due to lack of confidence
4.careful due to fear

41.poignant
1.deeply affecting the feelings
2.making very angry
3.helping to make happy
4.interfering with one's perception

42.amorphous
1.having a fine outline
2.soft and flexible
3.extending endlessly
4.without definite shape

43.lucrative
1.resulting in balanced profit and loss
2.gainfully employed
3.hard-working or industrious
4.producing wealth

44.adroit
1.marked by care and concern for details
2.marked by skill or resourcefulness
3.known to be talented
4.known to be helpful

45.mitigate
1.to cause to be more strong
2.to help by suggestion
3.to cause to become less harsh
4.to help by medication

APPENDIX D

STATISTICAL APPENDIX

Tests of Significance

The following test of significance tests the hypothesis that $\rho_{yz} = \rho_{xz}$ when computed for the same population (see Walker & Lev, 1953, pp. 256-257). This test uses the following statistic:

$$t = (r_{xz} - r_{yz})\sqrt{\frac{(N - 3)(1 + r_{xy})}{2(1 - r_{xy}^2 - r_{xz}^2 - r_{yz}^2 + 2\, r_{xy}\, r_{xz}\, r_{yz})}}$$

The value defined by this formula is assumed to be distributed as Student's t with N - 3 degrees of freedom. Given three variables x, y, and z from the same population, one wishes to know whether z is more highly correlated with x than with y, or vice versa. This test was employed for testing the following hypotheses:

1. The reasoning composite is more highly correlated with the accurate-definition score than with vague-recognition-without-definition.

   The correlations of the reasoning composite with the accurate-definition and vague-recognition-without-definition scores were .69 and .57 respectively. The correlation between the latter two was .85. The difference was statistically significant ($\underline{t} = 2.5$, $\underline{df} = 71$, $\underline{p} < .05$).
2. The reasoning composite is more highly correlated with the vague-definition score than with the vague-recognition-without-definition score.

   The correlations of the reasoning composite with vague-definition and vague-recognition-without-definition were .67 and .57 respectively. The correlation between the latter two was .88. The difference was statistically significant ($\underline{t} = 2.32$, $\underline{df} = 71$, $\underline{p} < .05$).
3. The reasoning composite is more highly correlated with accurate-recognition-after-definition items than with accurate-recognition-without-definition items.

   The correlations of the reasoning composite with accurate-recognition-after-definition and with accurate-recognition-without-definition were .72 and .59 respectively. The correlation between the latter two was .85. The difference was statistically significant (_t_ = 2.89, _df_ = 71, _p_ < .05).

4. The spatial ability composite is more highly correlated with concrete word items than with abstract word items.
   The correlations of the spatial ability composite with concrete word items and with abstract word items were .44 and .32 respectively. The correlation between the latter two was .83. The difference was statistically significant (_t_ = 1.94, _df_ = 71, _p_ < .05).
5. The memory span composite is more highly correlated with abstract word items than with concrete word items.
   The correlations of the memory span composite with abstract word items and with concrete word items were .53 and .43 respectively. The correlation between the latter two was .83. The difference was statistically significant (_t_ = 1.70, _df_ = 71, _p_ < .05).

Partial and Part Correlations

The correlation between the spatial ability composite and abstract word items was .44. The correlations of arithmetic reasoning (as measured by the quantitative achievement composite) with the spatial ability composite and concrete word items were .63 and .32 respectively. The partial correlation between concrete word items and spatial ability, controlled for arithmetic reasoning, was .32. The part correlation between them when arithmetic reasoning was partialled out of spatial ability was .31.

The correlation between the spatial ability composite and abstract word items was .32. The correlations of the arithmetic reasoning composite with the spatial ability composite and with abstract word items were .63 and .38 respectively.

The partial correlation between abstract word items and spatial ability, controlled for arithmetic reasoning, was .11. The part correlation between them when arithmetic reasoning was partialled out of spatial ability was .10.

APPENDIX Z

CORRELATIONS BETWEEN ABILITY COMPOSITES AND PERFORMANCE ON THE VARIOUS LEVELS OF THE FACETED VOCABULARY TEST

Correlations Between Ability Composites and Performance on the Various Levels of the Faceted Vocabulary Test (*N* = 74)

	Levels of the Faceted Vocabulary Test											
	Frequency			Abstractness			Item Type[a]					
Ability Composites	Frequent	Medium	Infrequent	Concrete	Medium	Abstract	VR without def.	VR after def.	AR without def.	AR after def.	VD	AD
Reasoning	69	67	68	68	66	69	57	64	59	72	67	69
WAIS IQ	66	63	65	66	63	65	55	57	59	67	65	66
Spatial	39	30	35	44	29	32	29	34	32	36	34	34
Memory Span	49	45	48	43	44	53	45	37	46	43	45	50
Closure Speed	27	16	11	25	12	16	29	16	14	16	20	14
Perceptual Speed	20	17	19	22	15	19	16	12	20	19	20	20

Note: Decimals omitted. r = .19 significant at .05 level.

[a] VR, AR, VD and AD represent Vague Recognition, Accurate Recognition, Vague Definition, and Accurate Definition.